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A MANUAL

OF THE

PRINCIPLES OF SURGERY,

BASED ON PATHOLOGY

FOR STUDENTS.

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PHILADELPHIA:

LINDSAY & BLAKISTON.

1866.

1816

Entered, according to Act of Congress, in the year 1866,

By Lindsay & Blakiston,

In the Clerk's Office of the District Court of the United States for the Eastern District of Pennsylvania.

SHERMAN & CO., PRINTERS.

PREFACE.

THIS volume was commenced while the author was engaged in lecturing upon the Principles and Practice of Surgery. Finding that a single session, although of six months, was not sufficiently long to permit him to embrace in his course both the principles and the practice of the science, he proposed to himself to prepare a handbook of the principles for his class, that he might thereby be enabled to devote more time to the practical part of the subject. Circumstances having led to his withdrawal from the college, he has been induced to extend the limits of the work to the present size, in the hope that it may be found more useful. In doing so great attention has been devoted to surgical pathology, believing that it is most essential to a knowledge of all rational treatment. The groundwork is mainly derived from the lectures delivered by him upon General Pathology and Surgery. In the preparation of those lectures the following works were freely consulted: Rokitansky's, Jones and Sieveking's, and Gross's Pathological Anatomy, Simon's General Pathology, Principles and Practice of Surgery by Miller, Cooper's Surgical Dictionary, Chelius's System of Surgery, and especially Paget's Surgical Pathology. Other works were also often examined. And in completing the work much assistance has been obtained from Virchow's Cellular Pathology and Holmes's System of Surgery. It follows that much contained in these pages may be found in those works, and it gives the author pleasure to thus make this distinct acknowledgment. But the author, in appropriating the labors of others,

was steadily careful to exclude what seemed irrelevant or unnecessary for his purpose, ever endeavoring to simplify the subject under consideration by avoiding useless technicalities; while at the same time embodying such appropriate facts as had come under his personal observation, and advancing such theories as thought and study had suggested to his mind. The illustrations, as will be seen, are taken from Paget's Surgical Pathology.

The arrangement and division of subjects are original, and the hope is entertained that they will be found advantageous to the student. The work has been prepared more particularly for the student, but the opinion is hazarded that it will prove useful to the practitioner.

That in these pages there will be found many imperfections is very well known; but the profession is requested to remember that this is the first undertaking of the kind in our young country. The writer enjoyed not the advantages of early literary training. As his grandfathers and his father were pioneers in the wilderness of Canada, and paved the way for a more scientific agriculture, so the writer hopes this volume will be the forerunner of other and more excellent treatises, that will hereafter proceed from the profession of our province.

Not having personally superintended the work through the press, there may consequently be found a few blemishes which the printer and proof-reader could not feel at liberty to remove.

Belleville, Canada West, January, 1866.

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ERRATA.

Page 33, 19th line from top, instead of "not going far to doubt," read "not going far to believe."

In Chapter II, at top of page, instead of "Diseases arising out of Inflammation," read "The Inflammatory Process."

Page 131, 14th line from top, instead of "the application of a coating or sedative lotion," read "the application of a cooling or sedative lotion."

Page 192, 9th line from bottom, instead of "the coats are so lacerated," read "the vessels are so lacerated."

Page 231, 7th line from bottom, instead of "rally," read "volley."

PRINCIPLES OF SURGERY.

CHAPTER I.

INTRODUCTION.

Nutrition—Development—Growth—Assimilation—The "Formative Process"—Ordinary Decay—Repair—Four conditions necessary for Repair.

In the following pages, I shall first treat of Inflammation, diseases arising therefrom, and its varieties; secondly, of the Healing Process; thirdly, of External Injuries; fourthly, of Diseases of certain Tissues; and fifthly, of Tumors, or morbid growths.

Although the inflammatory process and the healing process are distinguished by a separate consideration, I shall endeavor to show that *healthy* inflammatory action is a step—a first step—in the process of healing; that, while healing more expeditiously takes place when inflammation is absent, yet, under certain circumstances, the inflammatory process is necessary to prepare the way and supply the means for successful healing. When, however, the inflammatory action is *unhealthy*, when there is presented some one of the several *varieties of inflammation*, then there is a *de facto* disease. The distinction between the two will be found to be the same as that which exists between a healthy ulcer and an unhealthy one; when, in the former, healing kindly takes place in accordance with physiological laws, and in the latter it fails to take place.

In order to understand aright the phenomena of inflammation, it is necessary to bear in mind the physiology of healthy nutrition of tissues. It is essential to understand what takes place in the

ordinary course of life; the manner in which tissues grow, are developed, and their natural integrity maintained, notwithstanding the constant wear and tear of their substance. This knowledge of physiology is requisite, inasmuch as there is a very close resemblance between the process of nutrition and the commencement of inflammatory action, and also because of the striking analogy between the process of repair constantly going on in the various tissues and those steps taken by nature to heal the structure after a solution of its continuity; and, furthermore, because of the resemblance between all of the foregoing processes and those morbid conditions known as Hypertrophy and Atrophy.

In health, we have *development*, *growth*, and *assimilation*. These, together, may be called the "formative process." (Paget.) While there is a difference between development and growth, yet the two go on generally together until maturity of the body: thus, in the fœtus, development and growth go hand in hand; also in childhood, and up to mature age. There is, however, this manifest difference between the two, of which the student should have a distinct understanding: development is not necessarily an increase of substance, but an advancement,—an elevation to a higher state of existence; as, for instance, in the brain, the heart, &c. These are gradually developed from the most simple constituents to those of the most complex. Growth, on the contrary, means merely an increase in the bulk, taking place according to certain general laws. When the body is in a state of health, the one process attends the other; but either may proceed without the other; as, for instance, the brain may cease to grow at any period of fœtal life, while development continues; or the reverse may occur; that is, development may be arrested, although growth is continued. Paget, in his most useful work ("Surgical Pathology"), refers to two specimens: "Among the malformations in the museum of St. Bartholomew's Hospital, are the brains of two adult idiots. They are equally diminutive, and of nearly equal size: but in one, so far as we can see, there is a due proportion of the several parts; it is only too small: in the other, the parts are not well proportioned; the posterior parts of the cerebrum do not half cover the cerebellum; indeed, no posterior cerebral lobes appear to be formed. Herein we recognize something more than a checked growth; for this truncation of the cerebrum indicates an arrest of

its development at the time when its hinder lobes—the parts last produced, and peculiarly characteristic of the human brain—were only just beginning to be formed. Our explanation of this most interesting specimen must be, that, when the brain had attained that degree of development which, according to Professor Retzius, is proper to the human fœtus about the beginning of the fifth month, and corresponds with the completed development of the brain of lower mammalia, then its development ceased. But though in form it is like the fœtal brain in the fifth month, yet, in all its dimensions, it is larger; so that, although its development had ceased, its growth continued, and was not checked till the brain had attained the size of that of a mature fœtus. In this brain, therefore, we find at once defective development and defective growth; but in the other, the development proceeded, and the growth alone was checked." On the other hand, examples in which development was checked while growth continued, may be seen in malformed hearts, where only a single cavity exists, no partition having been developed; yet where growth proceeded in regular order.

At all periods of life decay in the body is going on. Every living body, everything indeed in all animated nature, has a limited period of life—has a period of growth, maturity, and decay; and so it is in the human body. Not only the body as a whole has its period of existence terminating in death, but every particle of tissue, every element which enters into the formation of the whole, has its own limit of life. It is begotten, it matures, it fades, it dies. This is independent of the life-course of the whole frame. And, from the earliest period of embryonic life until the heart finally ceases to beat, this process of limited life in the tissues is constantly being enacted. Paget gives two sources of decay in the tissue, or, as it is aptly expressed, of "wear and tear," one of which is exercise, and the other natural death, in accordance with a general law.

After growth and development are completed, assimilation—a process coeval with the life of the body—is the only remaining way by which the "formative process" is manifested. In passing, I may just state that these worn-out, or dead particles, are, when the body is in a state of health, duly removed from the system—excreted by some one or more of the excretory organs; or it may

be, according to the views of some recent writers, that some of their elements enter into new combinations and continue to serve the body in a new capacity. The constituents of some tissues of the body are endowed with a more protracted life than those of others; indeed, the function of some tissues is such that removal of effete matter and repair cannot with readiness conveniently take place; and hence the important provision by which those tissues are preserved from speedily wearing out—as the cartilages of the joints, ligaments, tendons of muscles, &c. It is, then, a physiological law, that some tissues should be more mutable than others: but, more than this, any one tissue may be rendered short-lived by unnatural weakness, which weakness may have primarily existed, or subsequently have been acquired; that is to say, a system, or an individual tissue, perfectly sound, will live and wear longer, under the same circumstances, than one which is defective. There is a close likeness between this life of individual tissues, and the being which they together compose. As every living being begets offspring like unto itself, so the constituents in their minor life cease only to live, when other similar ones are begotten and prepared to succeed them in the part they have played. It is this process which is called assimilation. This question, however interesting, cannot here be further discussed; for a complete consideration of the subject the reader is referred to Paget's "Surgical Pathology," and Virchow's "Cellular Pathology."

But not only does every elementary structure in the body decay and die; it, as well, under certain morbid influences, deteriorates, or degenerates—becomes changed in its essential character, in consequence of which it is incapacitated for a proper discharge of its duties; just as the whole body may, as the result of disease, become unfit to act its part aright.

We have now learned that, when the body is in a state of health, at all periods of life there is a constant loss being sustained by the elementary structure of the body, in some of which the loss is rapid, and in others tardy; yet invariably taking place. Now if the integrity of the body is to be maintained, repair must be made in the same proportion as there is loss. This *repair* is known by the term nutrition. I wish to call it repair, because I desire to show the close connection, or resemblance, perhaps I might say,

identity, of this process and that generally known as the Healing Process. Of this I shall more particularly speak hereafter.

At present let us glance at the "conditions" which are necessary to the efficient repair of every part of the body, so constantly being made, and for the successful carrying out of which we find nature so fully adequate. And I cannot do better than to give Paget's own words. "Doubtless," he says, "the conditions necessary to the normal nutrition of parts are very many; but the chief of them are these four:

"1. A right state and composition of the blood, or rather nutritive material.

"2. A regular and not far distant supply of such blood.

"3. (At least in most cases) a certain influence of the nervous system.

"4. A natural state of the part to be maintained."

With regard to the first. A builder, if he wish to have a perfect, a time-enduring edifice, will endeavor to procure good sound material for its construction; and so it is with respect to repair of tissue. To secure a continuance of health in the physical frame there must be a healthy condition of the blood—that fluid which streams to and from every part of the body, and whose current carries thereto the elements of nutrition, and therefrom those which have ceased to be tissue.

The second condition is, there must be a regular supply of such blood—not too much, not too little—at all times the same, to every tissue according to its necessities. It is the bread of life to the tissue, and the demand is imperative. If a tissue be not regularly supplied with blood, disease will result. On the one hand, if there be too little blood for a length of time, atrophy will follow; or, should it be entirely cut off, mortification will ensue. On the other hand, where too much blood exists in a part, it constitutes congestion, which may lead to inflammation; or a long-continued congestion may give rise to hypertrophy. These two different results of hyperæmia may depend upon other circumstances; but here can only be explained that a *sudden* influx of blood to a part is likely to produce inflammation, while a gradual and limited increase is more likely to be followed by hypertrophy. The power of assimilation belongs to every tissue; it is a law of life. After the body is fully grown the extent of assimilation in health will

depend upon the amount of decay, otherwise the natural condition will not be maintained. It would seem that a redundant supply of arterial blood, long continued, may cause the tissue thus supplied, to assimilate to a greater extent than there is wear and tear; the result of which will be hypertrophy.

The third requirement for ordinary repair of tissue is a certain nervous influence. Assimilation may possibly continue, although imperfectly for a time, notwithstanding the nervous influence is withdrawn; but very soon after its withdrawal the tissue will exhibit signs of impairment. Examples of this is often seen where nerve-trunks have been injured, or are pressed upon by a morbid growth. The tissue to which this nerve is distributed seems incapable of propagating itself. The absence of the nervous supply may prevent the normal circulation of nutritious fluid. At all events the result is *atrophy* of the structure.

The fourth condition necessary is a natural condition of the part to be maintained in a state of repair. Now, if a part has been originally healthy, and the three previously stated conditions be continually present, this, the fourth, will never be absent. If, however, the structure have been originally abnormal or weak, then, although the three conditions mentioned be not wanting, the fourth will not exist. Again, as has been stated, if one or more of the first three conditions be absent, it will result in a want of the fourth—that is, if the blood is not pure in composition, or if it is not regularly supplied to a part, or if there be a want of nervous influence, there will soon be an abnormal state of the tissue, so as to render it incapable of assimilating, even although the other conditions had been restored.

It does not come within the scope of this work to do more than allude to the physiological necessities to secure the above-mentioned requisites for repair of the constantly wearing-out tissues of the body. In the first place, as already intimated, a healthy constitution is a prerequisite; then there must be a natural volume of healthy blood, which must be maintained in its purity and fulness of quantity. In order to this, proper food, properly taken, followed by healthy digestion, and formation of blood, are essential. It is well to remember that chyle, just entered into the circulating blood, is not itself blood,—that changes of a vital nature have to take place before it can enter upon the high duty which it

is intended to perform. This crude material has to undergo a process of development. The blood, like the solid constituents of the body, is developed and grows. Within the blood-mass there is constantly to be found development, maturity, and decay; and the worn-out portion of blood is quite as much an effete material as those of the tissues. Consequently, where anything interferes with any one of the natural processes of blood development, there will be an imperfectly elaborated pabulum for the wasting tissues.

Again, it is necessary that effete matter should be eliminated from the blood,—those elements which can no longer serve any purpose in the physical economy. These products of decay are constantly forming, and an efficient state of the excretory organs is demanded. In the venous blood are found elements which are poisonous in their effects when not duly removed, and which are separated from the blood in the lungs by the substitution of oxygen. To insure this, a sound state of the lungs and pure air are required. When effete material is not excreted, proper development of the blood cannot proceed, and assimilation in the tissues is disturbed, or perhaps impossible. Moreover, their retention may be the source of a poison more or less destructive to the system, as in the non-excretion of carbonic acid and of urea.

If these functions of life referred to be quite normal, then the blood will be preserved at its natural standard,—will be duly fitted to repair wasted tissue in every part of the body. If not, then disease of some kind will surely arise.

In concluding this chapter, it may be stated, in connection with the foregoing, that, in order to have the healing process, hereafter to be described, successfully carried on, the same conditions and the same prerequisites are equally necessary; and it is because such is the case, as well as because of the close resemblance between ordinary repair of tissue and that which we may call extraordinary repair, where there is a palpable breach of tissue, that it has been deemed desirable to take this brief survey of these few physiological truths. And although a knowledge of inflammation may be acquired without having previously studied these points, the task would be less easy, the labor greater, the result less satisfactory.

DIVISION I.

INFLAMMATION, AND DISEASES ARISING OUT OF INFLAMMATION.

CHAPTER II.

Inflammatory Process—Incubation—Congestion—Inflammation Established—Stagnation—Changes in Blood—Fibrin—Change of Function.

I HAVE endeavored, in the previous chapter, to explain briefly the nature of natural nutrition, or repair of tissue in health, which of necessity is constantly going on. One of the conditions necessary for this, it will be remembered, is a proper supply of blood; and, if there be a limited increase of blood supplied to a part for a lengthened period, hypertrophy is likely to ensue. More of the blood will be assimilated than is required to repair the ordinary waste and decay in the part. Yet this increase of structure will be effected in accordance with the perfect laws of health. It is in this way that the arm of the blacksmith increases in strength and size; and, on the same principle, any organ of the body will become hypertrophied when called upon for some time to do increased duty. It would seem that the increase of work is a cause of limited irritation or excitation ("physiological stimulus") to the nerves distributed to the part. But it will not do to thus give the principles which are based upon the doctrines of the so-called neuro-pathologists, without adducing the later views, which are found embraced in the doctrine of cellular pathology; and I will allow Virchow to speak for himself. He says, page 288: "If now we proceed with our analysis of what is to be included in the notion of excitability, we at once discover that the different actions which can be provoked by the influence of any external agency, are essentially of three kinds; and I consider it of great importance that you should pay particular attention to this point, as it

will greatly assist you in the classification of pathological conditions, and because it is not wont to be set forth with particular distinctness.

"When, namely, a given action is called into play, we have to deal with a manifestation either of the *function*, the *nutrition*, or the *formation* of a part. It certainly cannot be denied that at certain points the boundaries between these different processes disappear; and that between the nutritive and formative processes, and also between the functional and nutritive ones, there are transitional stages; still, when they are typically performed, there is a very marked difference between them; and the internal changes which the individual excited part undergoes, according as it only performs its functions, or is subjected to a special nutrition, or becomes the seat of special formative processes, exhibit considerable differences. The result of an excitation, or, if you will, an irritation, may, according to circumstances, be either a merely functional process, or the effect may be that a more or less increased nutrition of the part is induced without there necessarily being any excitation of its functions; or a formative process may set in, giving rise to a greater or less number of new elements. These differences manifest themselves with greater or less distinctness, in proportion as the individual tissues of the body are more or less capable of responding to the one or other kind of excitation."

Again, he says: "You will be able to gather, from what I have communicated to you, that nowadays it can no longer be said, with any show of reason, that the nerves alone are irritable parts, but that we are irresistibly led to consider functional irritability at least as a property belonging to whole series of organs. Far less known, gentlemen, is that clearly demonstrable series of processes in which *nutritive irritability* manifests itself—that power possessed by individual parts of taking up, when excited by definite stimuli, more or less matter, and transforming it."

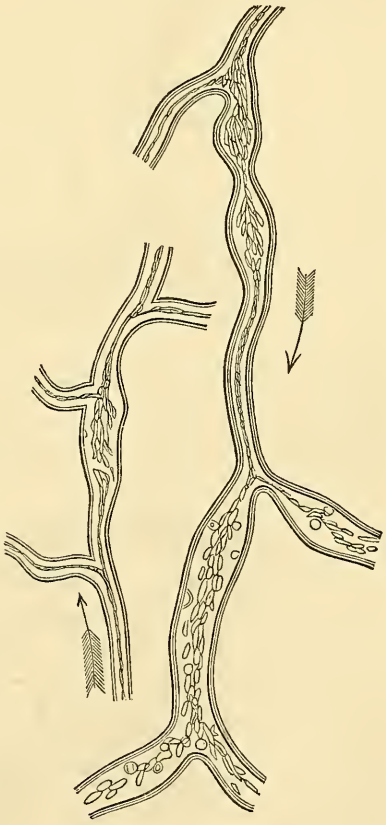
From this it will be seen that the important and exclusive part which the nerves have hitherto been supposed to play with regard to hypertrophy, and also to inflammation, is not unquestioned. Indeed it is almost apparent that the views formerly held in this as well as in other particulars, will have to be materially modified. The nervous distribution throughout the body cannot be said to

be general. Tracing the nerves to their final peripheral terminations, it is found that there are spaces into which no nerve is seen to enter, although this district seems to be none the less endowed with sensibility.

Again, in cartilage no nerves are found, yet the articular cartilage is not exempt from a high degree of sensibility. That the nerves have much to do in the various pathological effects of irritation, cannot be doubted; but it seems equally certain that the various tissues, when irritated, exhibit phenomena which are solely dependent upon powers residing within themselves,—a result of vitality belonging to the cellular constituents of the parts. This digression was necessary to a clear appreciation of the phenomena of inflammation.

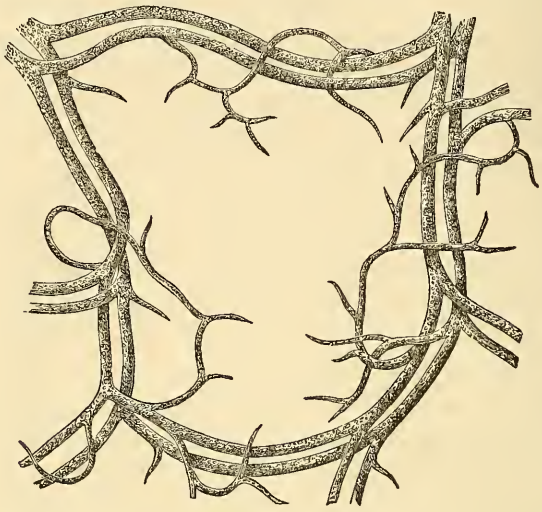
The effect made upon a part by a stimulus is soon transmitted to the nerves; and, according as this is great or long continued, it extends along the nerves to parts farther removed and to nerve-centres. Now, when the excitation is limited in degree, the result will not exceed the bounds of health (physiological stimulus); but when the stimulus extends beyond this, then the result will be of a morbid nature ("pathological irritant"). These results, so widely different when attained, are both reached by steps at first identical, and afterwards very similar. When a part is irritated, whether originating in the nerves or other tissue, the effect thereof is not confined to that part, but it soon makes known to other parts the fact that it is disturbed. Information is given by the nerve with electric speed; the message is carried to a nervous centre; it almost seems as if the electrical disturbance radiated from the point affected; and that, as it extended along the nerve-cord, it gradually lessened, until it finally ceased. In accordance with some law, perhaps not yet fully determined, there is a reflex nervous action, the result of which is an influx of blood; there is at once an increased activity manifested in the part. In the case of unusual exercise of an organ, this increased supply of blood is plainly a response to the call for more blood to increase the efficiency of the organ. If, however, the irritation be of an injurious nature, the increase of blood *seems to be intended to supply means either for expulsion of the irritating cause, or to limit its effects.* The blood flowing in greater quantity to the part finds, up to a certain point, increased accommodation; the smaller arteries and

the capillaries are increased in calibre, so as to allow the blood to flow through the part. The blood continuing thus to flow for a time, there may be exaltation of function, or nutrition, or a new formation; that is to say, if a gland be the seat of congestion, its function may be increased, or it may become larger by increase of its natural substance, or a new formation may result. But should the irritation exceed a certain degree, then other and different effects will follow the congestion. The blood rushing to the part, or attracted to the part, past a certain degree, seems to induce a contraction of the vessels; and *here may be considered the turning-point, the dividing line between physiological and pathological action.* The coats of the vessels, distended and irritated beyond their power to bear, strive to resist the overflowing blood and contract with spasmodic energy, and there is at once a disturbance of those conditions necessary for healthy nutrition. The vessels under the great irritation, after having been dilated to their fullest normal extent, spring, as it were, to recover themselves; and, like a muscle pierced by a spicula of bone, or the urethra irritated by a morbid urine, cease for the moment to be controlled by ordinary nervous power and spasmodically contract, and to such a degree that the calibre of the vessels is reduced below the natural size. The spasm, however, is of limited duration, and is succeeded by

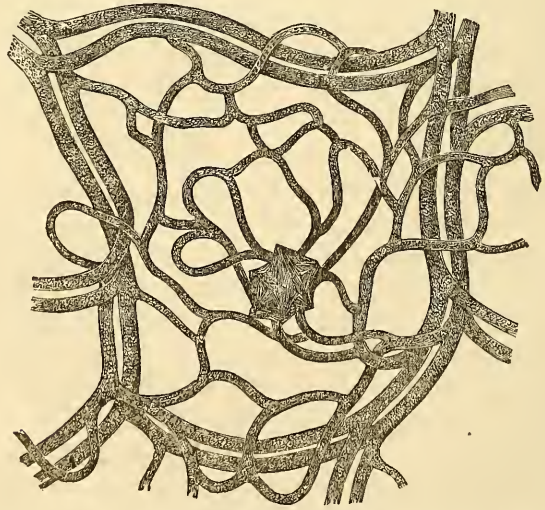


Irregular contraction of small vessels from the web of a frog's foot after the application of stimuli. Copied from Wharton Jones.

dilatation. This dilatation, unlike that which primarily took place, is the result of morbid action and a want of natural power in the



coats themselves. After an uncertain period of time the dilatation is followed by a second irregular contraction, the duration of which is shorter than the first. Again, dilatation succeeds, which is ever becoming greater, and characterized by a continued decrease



Diagrams contrasting the natural and the stimulated conditions in a segment of the vascular plan of the bat's wing. (Paget.)

of power and ability to contract in the coats; yet a third contraction may occur before the vessels are entirely overcome and paralyzed. Ultimately, however, this is the result. At any period during the time these phenomena are being presented, if the irritation be increased or varied, it is said the contraction will be greater than it otherwise would be. (Paget's experiments on the wing of the bat, a warm-blooded animal.) When the power to contract ceases in the coats of the vessels, then there is established a decidedly morbid condition. Already a most important step has been taken in the "inflammatory process."

In speaking of the above phenomena resulting from congestion, I have used the term vessels; because, and contrary to a commonly received opinion, in the capillaries they are not the most perfectly manifested. "A capillary vessel is a simple tube, which we have, with the aid of our present appliances, hitherto only been able to discover a simple membrane, beset at intervals with flattened nuclei." "It is this, the most simple class of vessels, which we nowadays solely and exclusively call capillaries," "and with regard to them we cannot say that they become wider and narrower by means of any action of their own, but at most that their elasticity renders a certain degree of contraction possible. Nowhere are there to be witnessed in them genuine processes of contraction or relaxation succeeding it." (Virchow.) But the important fact remains, that every vessel, whether classed under small arteries, small veins, or capillaries, does, under irritation, whether it be physiological or pathological, contract: in the absence of muscular fibre the contraction may be momentary and evanescent, but it always takes place before relaxation and dilatation. Consequently the less the power to contract the more speedy the paralysis, or total absence of power to contract.

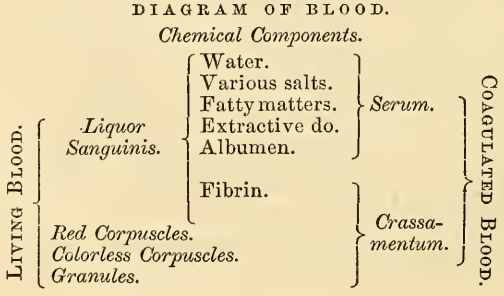
Continuing to trace the inflammatory process, let us now examine in what way and to what extent the *contents* of the blood-vessels are affected by this seeming paralysis of the coats. Reserving for a subsequent occasion a more minute description of the changes which take place in the blood of the part, and in the circulation generally, in consequence of inflammatory action, I wish here to point out only those immediate changes which occur in the blood occupying the paralyzed vessels. In health, the blood passes through the smaller vessels without impediment; the

red corpuscles occupying the centre of the channel, the white corpuscles rather pressing against the coats of the vessel, and being less certain in their onward movement. The nutrient matter transudes through the capillary coats with sufficient readiness to supply pabulum for the tissue. When there is a physiological stimulus, and relaxation of the coats succeeds a transient contraction, their exalted nutrition, as we have seen, may be expected to follow. When there is truly a pathological irritation, and a more complete relaxation results, then there seems to be a larger quantity of material transuded than can be appropriated by the tissues; and now, not only is there an increased amount, but the material is changed in character; perhaps it is more crude in its composition, and unfit for nutrition; or it may be the tissue, affected by the disease, is incapable of exerting any influence over the material transuded.

As the coats become more and more relaxed, and finally lose their power to contract, the quantity transuding correspondingly increases. Now, it is a question whether the material which, under such circumstances, passes through the coats of the capillaries, is identical in character and in quality with that which constitutes the tissues' aliment in health.

The exact chemical constituents of the nutritious juice which transudes in health, and which is taken up by the cellular structure, according to Virchow, and becomes tissue, has not been determined. The opinion long prevailed that fibrin constituted this material; but there are insurmountable difficulties in the way of continuing to regard *it* as so high a product. Rather must it be conceded that it bears evidence of being a material which is in the decline of life. The total of the fluid which transudes in inflammation is called liquor sanguinis, and is composed of serum and fibrin.

DIAGRAM OF BLOOD.



Now, may it not reasonably be supposed that the fibrin, thus placed without the capillaries, and unable to enter into the formation of tissues, either on account of its own beginning metamorphosis, or the inability of the tissue to appropriate it, or perhaps both, and having thus been turned aside from the high position for which it had been intended, assumes a new position in respect to its vitality, and its capability of acting any part in the operations of life in the system. Although it has, on account of circumstances, apart from its own development, failed in fulfilling its primary destiny, it constitutes a no less useful material. Although it may not act a part in ordinary repair of tissue, it serves a purpose quite as important and indispensable, in effecting *extraordinary* repair. The elements of the blood which would, had not the natural functions been disturbed, have become tissue, deviate from this natural course of development and become the agent of the *healing process.* The nature of this change is not uncertain; there is not only a change, but a degeneration—a descent from one state of existence to another. It is a retrograde development. Here the question as to nature and office of fibrin of the blood *in health*, might with propriety be discussed; but it will be more appropriately done in connection with the subject of *healing*. I will here simply venture the statement, that the object for which fibrin exists in the blood is to heal, or effect extraordinary repair. That it is a material limited in quantity, which is kept in store for that purpose, and which is always found to increase rapidly in quantity, and become more efficient in quality, when a demand for it is made. The varied ways in which it is employed will hereafter be duly considered, as well as the grounds upon which this belief is based.

Here, then, is a substance called liquor sanguinis, transuding, in consequence of the morbid irritation, which has resulted in overdistension of the vessels' coats. The fibrin of this compound is altered in character. It differs from natural fibrin in being more highly vitalized. It has degenerated from nutrient material; but it constitutes a higher type of fibrin than that which exists ordinarily in the blood. Derived from lusty elements which had been elaborated for nutrition, and suddenly exposed to conditions which caused an early degeneration, there results a higher type of fibrin, in which is manifested that high degree of vitality which, it will be seen, is so essential to a speedy restoration of the diseased

part. This fibrin is more plastic than the natural; and, not unlikely, this plasticity assists in delaying the ultimate stagnation of the blood in the vessels, to which there is a tendency thereafter.

The *cause of stagnation of blood* is another vexed question. While the state of paralysis was being reached, the flow of blood was becoming more and more tardy, and, finally, after oscillating in the vessel for a brief time, as if trying to force its way, it ceased to move—it was stagnant. The explanation of this has been sought by many investigators, and each of the individual elements of the blood has enjoyed the credit of being the cause, or one of the causes. Thus the white corpuscles, it is asserted by some, although strenuously denied by others, are increased in number, and in consequence of their crowding against the coats of the vessels they increasingly adhere, until the whole stream is interrupted. Again, the *red corpuscles*, it is thought, show an unnatural tendency to run together in the form of *rouleaux*, and in that way adhere together, as they are seen to do, in blood taken from the system even of a healthy person.

A. Microscopical appearance of healthy blood. B. Blood of a patient suffering from acute rheumatism or inflammation. (Paget.)

With regard to the *white corpuscles*, whether they in any way take a part, it is asserted by Paget, H. Bennet, Wharton Jones, and others, that, inasmuch as the white corpuscles cannot be separated from the fibrin, no positive evidence can be advanced in support of that theory. This view is opposed by Williams ("Principles") and by Virchow. Moreover, it has been observed that in those cases where the white corpuscles are in excess, the individual was otherwise unhealthy. And still more, these corpuscles are

relatively increased in pregnant women, and in those with tuberculosis, and in ill-fed persons.

That the *fibrin* acts a very important part in effecting the stagnation in inflammation, there is, I believe, a general belief; but in what way is not quite so certain. Increased in plasticity, it may, by adhering to the walls externally, tend to induce paralysis of the capillary coats. Again, it may be that, at least in some cases, the fibrin coagulates around the canal, and by contracting in places arrests the onward flow of the blood. But, as will be seen hereafter, coagulation generally does not quickly take place in the tissue under these circumstances; indeed, the increased vitality already said to exist in the fibrin teaches the same thing.

Probably, the principal cause, at least that which first leads to the stagnation, is the loss of tone or power to contract in the vessels. It has been demonstrated that even the smaller arteries and veins possess not only contractile tissue, but also muscular fibre. The capillaries, as well, have contractile tissue; indeed, although no muscular fibre has been detected in the coats of capillary tubes, it is not going far to doubt they, being a continuation of the larger vessels, would partake, although in a limited degree, of their character. May it not be that the bloodvessels perform an action analogous to that performed by the intestinal canal. It is difficult to conceive the object for which muscles exist in the coats of vessels if it be not to assist in passing the blood along the canal. The heart has long had imposed upon it the responsibility of forcing the blood to every part of the body; but it will not diminish the importance of that organ to admit that it may be assisted by the vessels themselves. With regard to the capillaries, there is certainly reasonable doubt as to their power to assist (*vide* Virchow, already quoted); if, however, it be true that some vital action residing in the extra-capillary cells causes the fluid to permeate these minute tubes, then it may at once be inferred that this cellular power is disturbed or destroyed in consequence of the morbid action going on, and hence the stagnation.

We have now reached a point in the "inflammatory process" at which a change of function is apparent. All the conditions necessary to healthy nutrition are absent, the blood is stagnant, the nervous influence is deranged, assimilation impossible, the period of incubation has passed,—the disease is established.

CHAPTER III.

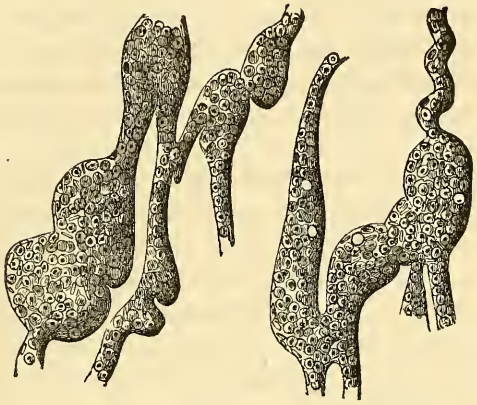
More Extensive View—Number of Products, viz., Serum, Liquor Sanguinis, Fibrin, or Inflammatory Lymph, &c.—Causes of Inflammation—Various Divisions.

THUS far, in studying the inflammatory process, our attention has been necessarily confined to a single vessel. Now, let us take a more extensive and comprehensive view of the inflamed part. Not only one but several, perhaps many, capillary vessels will be simultaneously involved; be affected in all respects the same; and finally in all, about the same time, the blood will cease to move. Extending the view, it will be seen that in the immediate neighborhood of these paralyzed vessels are others, undergoing those primary changes which have been described, and which are duly affected in the same manner as were those primarily affected. Continuing our observation to tissue farther removed from the central point of disease, there will even yet be observed active congestion or limited excitement, and apparent efforts being made to make accommodation for the in-rushing blood.

In speaking of the dilatation, over-distension, and final paralysis, I did not state the important fact that the vessels are not alone increased in calibre, but are, as well, elongated. The small vessels, indeed, present a varicose or tortuous appearance. Moreover, they are not uniformly dilated, but here and there they present a sacculated appearance, as seen in the annexed diagram. Now, must not this be considered an already anxious preparation of nature to form new bloodvessels in connection with the plastic material which has been copiously effused for the purpose of completing repair, should the inflammatory action fortunately be arrested? These points of sacculation may very easily be converted into offshoots, and, as will be seen hereafter, thus made to afford channels by which blood may be supplied to complete the healing process.

There are certain products of inflammation which will have to receive attention as we continue to trace the inflammatory process.

At present I will only enumerate them. They are, 1st. Serum; 2d. Liquor sanguinis; 3d. *Inflammatory lymph*, or altered fibrin; 4th. Blood; and, 5th. Altered mucus. These are immediate



Small vessels of an inflamed pericardium. (Paget.)

products of the disease, but there are others which are more remote, yet of no less importance. These latter products result from changes which may take place in the lymph, and from the effects of that product upon the tissue involved. Speaking generally, the lymph may become organized, as will be hereafter explained, or it may degenerate into pus. Before proceeding to fully consider these products of the disease, I purpose to consider the various

Causes of Inflammation.—They are numerous and varied, but may, by classification, be made easy to remember.

A common and convenient division is into predisposing and exciting; or, it may be, into local and general, or external and internal, or specific and non-specific. The predisposing causes may be subdivided into *local* and *general*. A local predisposing cause may have been inherited, or it may have been acquired after birth. It is a fact frequently observed that a certain tissue or organ is preternaturally weak, a condition which has existed all the lifetime, or since a certain period of life. A tissue thus weak is more liable to be attacked with disease than those which are in health. Individual tissues or organs, like individual persons, are, in consequence of imperfect development, more subject to the casualties of life. It requires no proof to make it plain that cer-

tain parts of the fœtus may be imperfectly developed in consequence of faulty conception or faulty uterine nourishment. The vice or imperfection of either parent may be represented in the child; or certain other influences may affect the integrity of the ovum or the more mature fœtus, so as to mar the process of development. Mal-nutrition, either during fœtal life or after birth, or an attack of some disease, may beget a condition permanently weak in a part, whereby that part is susceptible to any exciting cause of inflammation.

It has already been shown that certain conditions are necessary to secure healthy nutrition—natural repair; and that if but one of these conditions be absent, there will follow, sooner or later, a morbid condition in the part affected; and when the body is exposed to an exciting cause of inflammation that morbid tissue is likely first to feel the effects. But the whole system may be predisposed to inflammation. Primarily the whole structure of the body may have been defective; or, secondarily, the blood may have become vitiated. This general defect may have been induced, or it may be a heritage. When acquired there are many causes which may have been in action. The blood may be impure. It may always have been so, or it may have become so, as the result of imperfect performance of duty on the part of certain organs, or from the reception of crude or deficient aliment, derived from vicious food, or from taking too much, or perhaps too little food, or it may be from a failure in digestion. Again, the blood may not be duly developed. The conditions necessary for this may be wanting. Impurity of the blood, so injurious to health and the well-being of tissues, will ensue, if that fluid be not continually aerated, or if morbid material should enter by the lungs. If one or more of the excretory organs fail to discharge its function aright and the effete matter—those elements which have formed a part of the fabric, but which now have perished, and are floating in the fluids of the body—be not duly removed from the system by the kidneys, or the skin, or the bowels, then it may be the blood will be poisoned, and individual tissues in consequence become sufferers, and therefore predisposed to inflammatory disease.

Still, again, the blood, in consequence of a certain condition in which it happens to be found, or in consequence of being possessed of certain elements, may receive from without poisonous elements,

specific elements, which possess the power to beget specific inflammatory disease, such as small-pox, measles, scarlet fever, &c. Still further may be mentioned the taking of too much food, even though that food may be digested. When a state of plethora is induced by overmuch eating, the blood can scarcely be in a healthy condition, but rather becomes gross and ill-fitted for nutrition, and a predisposing cause of inflammation, ready to act, should any part be subjected to pathological irritation. Lastly, changes of weather, by which the body is exposed to great and sudden variations in temperature, whereby nutrition and development are impaired, will, if long continued, render the whole system liable to inflammatory disease.

Exciting or Local Causes of Inflammation.—The first are those which actually injure organized structure, as mechanical injuries and chemical agents, which tend to immediate destruction of tissue; also heat, extreme cold, and friction. 2dly. Those which act through the sentient extremities of the nerves, as concussion, pressure, irritating applications, as mustard, cantharides, &c. 3dly. Anything which produces a peculiar impression and gives rise to a specific action of an inflammatory nature, such as decomposed animal matter, pus arising from specific diseases, dissecting wounds, &c. A fourth class of causes is given; that is, such circumstances as produce a sudden change in the feeling of a part as that experienced in the viscera of the abdomen after the removal of fluid in ascites. Under this class may be included any change in local nerves, whereby deviations from normal nutrition may take place. (Simon.)

The terms *specific* and *non-specific*, as applied to causes of inflammation, scarcely require to be explained. They are almost synonymous with *unhealthy* and *healthy*, a division already indicated, yet an inflammation may be unhealthy without being specific. A specific cause of inflammation is one which gives rise to a definite kind of inflammation, as in the poison of small-pox and of syphilis, &c. A non-specific cause is one which has a more general source.

CHAPTER IV.

Symptoms of Inflammation—Causes of each—Value in Diagnosis.

And now, bearing in mind the varied causes of inflammation, and fixing the attention upon the pathological condition of an inflamed part; not alone upon a single vessel, whose coats are paralyzed, and from which exudation of liquor sanguinis is copiously taking place, but upon a wider district, in which are to be found many vessels in the various stages of the inflammatory process; some with blood stagnant, some in which it moves sluggishly, some through which it rushes with increased speed,—taking this more comprehensive view of an inflamed part, it will be a more easy task to consider the various *symptoms* which characterize the inflammatory process, so far as we have traced it, and to examine the symptoms which may be looked upon as diagnostic marks of the disease.

The symptoms of inflammation may be divided into local and general. The local are pain, heat, redness, swelling, to which is commonly added throbbing. Pain is a very early and constant symptom as a general thing, and such would naturally be expected. It is the office of the peripheral extremities of the nerves to guard the structures wherein they are distributed, and to give warning to the central system on the approach of danger. The invitation by which the inflammatory process is initiated, acting upon and through the nerves, will from the first produce uneasiness in the nerve-tissue itself, and prompt and constant pain is the common result of the inflammatory process. The pain of inflammation may be said to arise from two causes, one of which is disturbance of or injury to the nerve-substance; the other is derived from indirect effects upon the nerves, due to the morbid condition of the tissue,—changes, perhaps, in the cellular elements, and the free transudation which follows the paralysis of the vessels. The in-rushing blood may be supposed to increase the pathological irritation which has arisen by pressing upon the irritated nerves while

in a disturbed state; also the several products of inflammation, the exuded serum, the liquor sanguinis, and subsequently the pus when it has formed, will, no doubt, in like manner by pressure maintain and increase the pain. But the pain of inflammation is not always alike with the same cause and amount of inflammation. The intensity of pain depends upon the nature of the tissue involved. If it be abundantly supplied with nerves, the pain will necessarily be greater. Again, if the tissue be dense and unyielding, the pain will be correspondingly great. For instance, in inflammation of the periosteum, a dense, unyielding, fibrous membrane, the pain is very great; and the same is witnessed in the bone itself when inflamed, also in the torturing toothache. In such tissues where the nerves are irritated, attended by congestion or effusion, the pain becomes exquisite; for, with the pressure, there is an equal counter-pressure. On the contrary, when the so-called cellular tissue is the seat of inflammation, the pain by no means corresponds with the actual amount of inflammation. This difference between certain tissues of the body with regard to susceptibility and inability to accommodate themselves to abnormal conditions, bears an analogy to that well-known difference which exists between individual beings. All persons are not equally affected in the same degree of inflammation, or in any other disease. Some individuals are more sensitive than others; and some tissues are likewise more sensitive than others, although in other respects there may be equality.

To what extent may pain be considered a *diagnostic* mark of inflammation? It must be mentioned that pain may be absent in consequence of paralysis; it therefore cannot be recognized as an infallible diagnostic mark; but when pain is absent in consequence of paralysis, the most superficial observer will be able to discern it. On the other hand, pain attends other diseases as well as inflammation. The *pain of neuralgia* is very severe, but it may be distinguished from the pain of inflammation by the manner in which it commences. Unlike the pain of inflammation, it is sudden in its onset, and is quite as severe at first as at any subsequent period, while at the same time there will be an absence of the other ordinary symptoms of inflammation. Again, the pain of colic may be mistaken for that of inflammation; indeed, it is very commonly done by the non-professional; but this, also, is sudden in its ap-

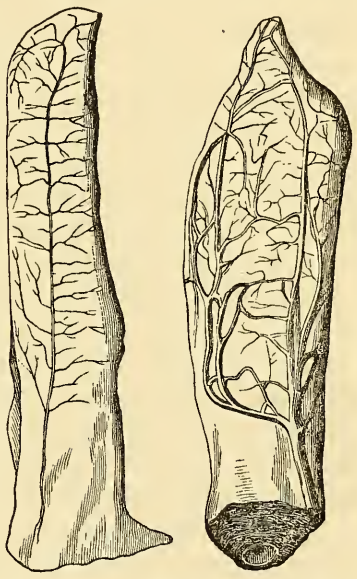
pearance, and is often as great at first as at any subsequent time. Moreover, the pain of colic is relieved by pressure, while the pain of inflammation is always increased thereby. And, it is important to add here, if during the course of inflammation in an internal organ the pain suddenly cease and does not recur, it is always to be regarded with concern, inasmuch as it indicates that the tissue involved has lost its vitality; that indeed gangrene has commenced, and that the relief which the patient so much enjoys is but a foretaste of that ease from bodily pain which death brings.

Heat is a very constant symptom of inflammation. A difference of opinion prevails as to the cause of this symptom. Physiologists do not quite agree as to the source of animal heat in the human body; as to the nature of that process by which a certain amount of heat is constantly created in the body. All, however, are agreed that in the process of nutrition there is a certain amount of heat regularly developed in every part of the body. Wherever the blood flows, there heat is evolved. It may be by waste of tissue, or it may be by some strictly chemical change in connection with the transudation which takes place through the capillary coats; but it matters not for our purpose as students of the science of surgery. It is sufficient to know that the process by which heat is produced in the body in health, or some like process, is found to be actively at work where inflammation has been kindled, and consequently in that part a superabundance of heat is always found to exist. Simon has, with seeming satisfaction, demonstrated the fact that the temperature of a part inflamed is greater than that of the arterial blood going to the part, and that the heat of the blood going from the part is less than the temperature of the blood in the part, while at the same time it is greater than the blood in a corresponding artery.

Heat, in most cases, is a trustworthy *diagnostic symptom* of inflammation, but it is not altogether so. The heat may seem to be great to the patient in consequence of a morbid state of the nerves; and again, a structure inflamed, when freely supplied with nerves, may seem to have a higher temperature than it really has, as will be found by actual experiment. It is barely necessary to point out the difference between the heat of inflammation and that which characterizes the burning cheek of shame, and also that of hectic. They can always be distinguished from the absence of all the symp-

toms and circumstances of inflammation in the one case, and the presence of graver constitutional symptoms in the other.

Redness.—In inflammation the flow of blood is increased to the affected part, and as the capillary coats gradually yield under the constantly increasing pressure, greater space is allowed for the presence of red corpuscles. Small vessels, through which the corpuscles could but pass in single file, have crowding through them much larger numbers. Bloodvessels are not suddenly formed in an inflamed part, as was at one time supposed. The redness is due to this crowding of the distended vessels by red corpuscles. The liquor sanguinis exudes, leaving the corpuscles mainly to occupy the capillary tube. Often the little cells will break down, or part with the coloring matter, which will tinge the transuding liquor sanguinis.



Enlargement of vessels, shown in Hunter's specimen of the ears of a rabbit, one of which was inflamed by thawing it after it had been frozen. (Paget.)

Redness, although a constant symptom of acute inflammation, may not be recognized as a *certain sign* of the disease, for redness sometimes results from other morbid conditions. There are certain conditions of the blood, as in scurvy, where the red corpuscles easily part with their coloring matter, which, being admixed with the serum, may collect in a part, and give rise to a very high degree of redness. The intensity of the redness, whatever may be the cause, will, of course, vary much, according as the blood is arterial or venous. In the former case it will be of a brighter hue; in the latter it will be darker, perhaps even dusky.

Swelling.—When a part becomes inflamed there is a tendency therein to swell; the relative size of that part is increased. The supposition would naturally arise that an increase of blood would increase the volume to a corresponding extent, and generally, no doubt, such is the case. Yet the vessels may be dilated so as to

contain a very much larger quantity of blood than is natural, and at the same time the structure in which these vessels are located may be lessened in dimensions (perhaps by the pressure of the dilating vessels), so that the natural volume of the whole is retained. In the first step of the inflammatory process such is the case, but when the coats become paralyzed, then the liquor sanguinis occupies the intercapillary substance. Indeed, the cells of which the tissue is composed are soon engaged in a morbid action,—unnatural development. They individually swell by imbibition of the fluid which has transuded. (Virchow.) In those tissues which are yielding the swelling will be greater than in those which are not. And here I wish to point out the important fact that swelling is salutary in its effects; it may, indeed, be looked upon as a curative effort. In a given amount of inflammation in a certain tissue, the degree of pain to some extent depends upon the amount of swelling which attends; that is, whether the tissue is yielding or otherwise, for we have already learned that inflammation of dense tissue is more painful, because the irritated nerves are more pressed upon. Consequently, when swelling takes place, one of the most active agents in feeding the inflammation is removed or modified. Swelling then relieves the irritated nerves, and tends to arrest inflammatory action. The degree of swelling, we have seen, will depend upon the nature of the tissue or organ involved.

As a *diagnostic symptom*, swelling is not very trustworthy. It has been shown that considerable inflammation may exist without a corresponding amount of swelling. Moreover, swelling often takes place independently of inflammatory action, as in passive congestion, where there is a mechanical obstruction to the return of venous blood, or when something interferes with the circulation of blood in a part.

These four symptoms, pain, heat, redness, and swelling, when taken singly, cannot be said always to indicate inflammatory action,—are not diagnostic marks; but when two are found coexisting, the one increases the importance of the other; and when the whole four are seen in connection, they may be regarded as very reliable symptoms of inflammation.

Another symptom, which is mostly always given with the foregoing, is *throbbing*. It may be said to indicate a certain stage of the disease, to which we have not as yet traced the inflammatory

process, namely, *commencing suppuration.* This sensation of throbbing is due to the wave of blood which, coming from the heart, endeavors to force its way into and through the inflamed part, and which, being obstructed, causes the arteries and heart to labor in their efforts to overcome the obstruction. Every wave of blood increases the pressure already felt by the sensitive nerves; and the pain, constantly experienced, is at each pulsation intensified for a moment, and hence the throbbing.

Other local symptoms are sometimes given in connection with the above, as derangement of function. It is, however, unnecessary to say more here than that the absence of the natural conditions necessary for nutrition infers derangement of function.

Constitutional Symptoms of Inflammation.—The system generally does not remain impassive or unaffected when a part of the body is inflamed. There is a most intimate connection between one part of the body and every other part, so that one part or organ cannot long go in pain or be disturbed without the whole taking cognizance of the local distress, and to a great extent becoming affected thereby. The quickness with, and extent to which this is accomplished, will depend upon the degree or intensity of the local affection, and the susceptibility which may attach to the constitution.

The general symptoms may all be included under the general term "inflammatory fever." Fever is always present when inflammation is at all worthy the notice of the surgeon. It is generally preceded by a well-marked chill, which is of short duration and varying intensity. The fever is characterized by a dry and heated skin, and an arrest of all the secretions. How is this fever produced? In the first place, the irritation and pain which give rise to, and also result from the inflammation, and which cause irregular action in the vascular structure of the part, gradually produce a similar effect upon the whole vascular system, including the heart itself. The morbid action of the vessels in the affected part, characterized at first by increased tone, seems to extend by continuity along the network of capillaries and the smaller arteries, and then on to the heart itself. The prompt manner in which the heart sometimes becomes affected and increased in action would lead to the belief that it was through the nerves' reflex action that the constitutional irritation was created.

In the second place, the blood becomes gradually contaminated by the products of the local disease. In consequence of those changes which we have seen take place in an inflamed part, a poison is engendered. This poison, by collateral circulation, soon finds its way into the general circulation. In this way certain changes are effected in the whole volume of blood, which will be fully explained hereafter. What is important here is the fact that the blood, thus poisoned, acting in conjunction with the nervous irritation already referred to, gives to the whole vascular system, including the lymphatics, an unnatural degree of tone, and this is the commencement of inflammatory fever. The explanation of this can be easily understood. The vessels contract, and thereby their calibre is diminished. The coats are brought into such a state that transudation of fluid cannot take place, at least as in health. The pores, so to speak, are closed. At the same time the heart labors, and the blood hurriedly streams along to and from every part of the body incapable of supplying nutriment to or carrying effete matter from any structure. If, under such circumstances, the skin be examined, it will be found there is an absence of the usual moisture,—there is no perspiration. The skin is dry while the blood is welling forth from the heart with determined force into the integument, in common with every other part of the body. The amount of heat generated in the body at such times is probably greater than in healthy action, while at the same time the absence of evaporation from the surface of the body tends very much to increase the temperature. Here, then, is an explanation, easy and simple, of two common symptoms of inflammation, namely, excessive heat and dryness of skin.

This increase of tone, or closeness, I may say, in the texture of vessels, by which transudation is arrested, is exhibited as well in the lymphatic and glandular structures, so as to affect the various sources of excretion. Secretion cannot go on as in health; hence the fact that in inflammation the urine becomes scanty. But little fluid can transude, and that is loaded with the effete matter of the body so as to make it highly colored. The bowels, also, are constipated, because the various glands connected therewith are incapable of action, the vessels therein being contracted, and there is but little secretion upon the mucous surface. The tongue, in common with other parts of the primæ viæ, participates in the general

disturbance, and, as it comes under convenient notice, its appearance is anxiously studied by the surgeon. The papillæ of the tongue stand out prominently and with unusual redness, and the surface generally is covered with a whitish or brownish coat, due to the partially arrested and changed condition of the mucus, while the borders of the organ are reddened.

The head is also more or less affected in inflammation, there being generally headache, with some obtuseness or disturbance of the mental faculties. This may be the effect of nervous sympathy, at least in part; for there is at all times a close sympathy between the head and the bowels. But the cerebral disorder is also in part due to the state of the bloodvessels within the head, which will participate in the common vascular excitement. These various constitutional symptoms are not likely to be mistaken, and when preceded by and accompanied with the local symptoms, *the diagnosis* of the disease is most certain.

CHAPTER V.

Prognosis of Inflammation—Course and Termination, viz.: 1. Resolution. 2. Delitescence. 3. Extension, first, by Continuity; second, by Contiguity; third, by the Circulation—Each explained—Fibrin in the System and out of it—"Cupped and Buffed;" fourth, by absorption; fifth, by the agency of the nerves.

The decision of the surgeon with regard to prognosis will depend upon a variety of circumstances, such as the *age* of the patient, the *constitution*, the *cause of the disease*, the *stage*, and the *general surroundings* of the patient,—the care and attention he will probably receive, and the faithfulness with which the surgeon's instructions will be carried out.

As a general thing inflammation runs high in the young, and also up to middle life; at the same time its course is sooner run to one or other termination. In the young the powers of life are active, and quick to resist anything which causes pain, and speedy in their efforts to get rid of the irritation and to effect restoration. These wayward doings in the young may lead to serious results.

On the contrary, in the aged there is a comparative slowness to redress an evil condition, to attempt to get rid of a cause of irritation, and to regain the normal state.

The constitution of the patient will be fully considered. When it is quite sound we have circumstances analogous to those just mentioned as characterizing inflammation in the young; and when it is unsound they are analogous to the condition of the aged in this disease.

The cause or causes of the inflammatory action must be remembered in order to form a correct prognosis; the predisposing cause and the local cause, whether each can be readily removed or not, and whether it is potent or otherwise. The stage of the disease also will govern the prognosis; that is, the extent to which morbid changes have taken place in the part, and the effects thereof on the constitution. And lastly, the course and termination of the disease will often and very much depend upon the position of the patient, and the fidelity with which the various directions of the surgeon are adhered to. Too often an overwise nurse, or an attendant led by inconsiderate kindness, acts contrary to essential orders in regard to remedial measures, and consequently the surgeon's calculations are subverted.

The surgeon will be expected to give his opinion, first, as to whether the life of the patient is in danger; and secondly, in respect to the integrity of the tissue or organ affected; whether it is likely to be permanently or seriously impaired; how long a time must elapse before a cure can be expected by the unaided powers of nature, or by the assistance of the surgeon; or how long will it probably be ere the irresistible fatal termination will arrive. These are the questions which will have to be replied to in rendering a complete prognosis.

The Course and Terminations of Inflammation.—At any time during the inflammatory process, it may be arrested and *resolution* supervene. If the cause be removed before the inflammatory action has too far advanced, resolution may quickly supersede the morbid action. And here I must not omit to point out the interesting and important fact, that many of the phenomena of inflammation are clearly indications of nature, intended to remove, if possible, the cause of the inflammation; as, for instance, when a grain of sand is lodged in the eye, the immediate effect is a

copious secretion by the gland, and thereby, in many cases, the offending object is washed away. Other instances might be adduced to show the same kind workings of nature; but I shall hereafter have occasion to dwell on this fact, and also point out certain morbid conditions which evidently indicate curative efforts.

The terminations of inflammation may be given as follows: First, into Resolution; secondly, by Delitescence, or by what is called *metastasis;* that is, morbid action may pass away *entirely* (delitescence), or it may disappear from one place and appear in a second place (metastasis). The latter is often seen in connection with gonorrhœa, a specific inflammation; the disease commences in the urethra, and after a time it suddenly ceases in that membrane, and simultaneously attacks the testicles. Thirdly, the inflammation may extend to other structures. This may take place, 1st, by *continuity*, along a membrane in the same tissue, as from the Schneiderian membrane to the mucous membrane of the larynx, and to the bronchial tubes; or from the duodenum to the liver, along the ductus communis choledochus. 2dly, by *contiguity;* that is, from one tissue to another which lie in contact; as from the mucous membrane of the intestine to the muscular coat, and then to the serous portion; or from the periosteum to the bone, and *vice versa*. 3dly, the disease may extend through the agency of the circulating blood. The fact has been before stated, that during the progress of inflammation the blood, sooner or later, becomes seriously affected, which causes, or assists to produce inflammatory fever. The blood may be so impregnated with poison, that, as it courses from the inflamed part, it will carry disease to other and remote parts, where, perhaps, in consequence of some predisposition, inflammation is also established.

It now becomes necessary to consider more particularly in what these changes of the blood consist—what is the condition of the various elements of the blood when it thus possesses the unnatural power to produce inflammatory disease in a part remotely situated from the tissues originally affected. Looking for a moment at the blood when in a state of health, as it circulates in the body, it may be divided into the fluid and solid constituents; the latter floating in the former. The fluid, or liquor sanguinis, is composed of the serum and the fibrin. The more solid elements are the corpuscles, red and white, and some granular matter. The serum of the

liquor sanguinis is composed of a large quantity of water, albumen, salts, and fatty matter. Now, if this healthy blood be taken from the system, the following changes will be observed to take place. Under ordinary circumstances, the blood soon ceases to be altogether fluid; the fibrin, instead of remaining in a soluble condition, begins *at once* to solidify, coagulate, and separates itself from the serum; while it embraces in its substance the corpuscular elements. In this way the blood is divided into a clot and the serum. The change is altogether due to the action of the fibrin. But when inflammation exists, blood taken from the body exhibits somewhat different characteristics, the first and most striking of which is, that some time will elapse before this coagulation of the fibrin commences to take place, and when, finally, it has been effected, the clot is found to be unusually firm and tough. Before attempting to account for these phenomena, it will not be out of place to allude to the important question, which has of late so much engaged the attention of physiologists and pathologists; namely, what is the office of the fibrin in the human system? Upon this subject there is even yet some difference of opinion. The statement of Carpenter, that "albumen, fibrin, and organized tissue are somewhat of the same nature as that which exists between the raw cotton, the spun yarn, and the woven fabric," cannot be received at the present day; indeed he has, in a later edition, very materially modified his teachings in this respect. He admits that fibrin does not constitute the pabulum of repair for wasting tissues in the higher structures of the body; and such, certainly, it has been proved, is a physiological fact. Now, if such be the case, the inference is forced upon us, that it cannot be the most highly developed or vitalized element of the blood. Moreover, if some tissues of the body derive their nutriment from other elements of the blood than fibrin, it must be conceded that those elements may possibly supply reparative material to all. Fibrin, so long exalted as the highest element of the blood, and as the one which directly entered into the construction of tissues, cannot readily be compelled to take a lower place; but the discoveries of recent physiologists necessitate that humiliation. But, although fibrin may no longer occupy so proud a position as that of being a reparative material for ordinary waste and decay, it does fulfil a no less important duty in the physical economy;

namely, that of supplying material for *extraordinary* repair. The tissues of the body are constantly exposed to the vicissitudes of life—to disease, and to accidents—and nature would fail to maintain her reputation as a conservator, and as wise to provide all things necessary for life, did she not have in readiness an agent to meet the sudden requirements of disease, and of the various disturbances to which the tissues are continually exposed. Herein, I would venture to assert, consists the importance of fibrin. This is the special object for which it exists. It is by this that the "healing process" is carried on. Of this I shall have to speak hereafter; so much, however, it was necessary to say here, that we might be prepared to understand that, during the inflammatory process, this element becomes endowed to a fuller extent with those attributes by which it is capable of acting an important part: no less, indeed, than that of restoring the structure inflamed to its normal condition, when at any time the morbid action may have ceased; nay, even more, that of arresting the inflammatory process, and thereafter of healing.

During the inflammatory process, the fibrin is said, at least by some, to increase in quantity; but Paget says such is not invariably the case. Of this fact there is no doubt, that its plasticity becomes greater—that its vitality is increased by the inflammatory action. Coagulation is the last act of life in the fibrin; and when it refrains from this act for a time, after being separated from the circulating blood, it indicates increased vitality. Now, such is observed to occur in the fibrin of inflamed blood; but when coagulation does take place, it forms a mass in which higher efforts are exhibited to form a permanent structure. However, when the clot is entirely removed from the body, it has its limited period of what might be called its rigor mortis (Simon), after which disintegration of its substance commences.

The blood of inflammation, by remaining fluid for a time when drawn into a vessel, allows certain changes to take place in the individual elements which do not occur in healthy blood, when it promptly coagulates. In that case the blood coagulates, the several constituents retaining their relationship as when circulating in the body. But when blood stands in a vessel uncoagulated, as it does in inflammation, the more solid corpuscles gravitate toward the bottom of the vessel. This sinking of the red corpuscles is facili-

tated by a peculiar property they possess of attracting one another and adhering together in a very regular manner in the form of rolls (see diagram). The consequence of this action is that fibrin alone occupies the surface of the mass. The natural color of fibrin is a light yellow, and the surface of the clot, instead of presenting the color which red corpuscles would have imparted to it, has that *buff* hue which is always referred to in connection with inflammatory blood.

The superficial portion of the fibrin coagulates first, while the lower stratum is crowded with corpuscles. These corpuscles in sinking drag upon the superior solidifying coat: the clot at its circumference being attracted by cohesion to the side of the vessel, and thereby counteracting the weight of the corpuscles, the central portion will be principally affected by the sinking bodies. In connection with this, another property of fibrin is exhibited; that of contraction as it coagulates. It not only solidifies, but its volume is lessened at the same time. It contracts into a narrower space, squeezing out the serum. The lower stratum is the last to coagulate and contract, and the result is that the surface of the buffy coat is depressed at its centre or *cupped*. This is another characteristic of the clot of inflammatory blood. In the coagulation of inflammatory blood, according to Paget, no distinction nor separation can be detected between the fibrin and the white corpuscles. Virchow, on the contrary, observes, that "on looking for the colorless corpuscles, we find them forming a separate layer at the lower border of the buffy coat. This peculiarity is simply explained by the different specific gravity of the two kinds of blood corpuscles. The colorless ones are always light, poor in solid matter, and very delicate in structure, whilst the red ones are as heavy as lead in comparison, owing to their richness in hæmatine."

Such is the state of blood in inflammation resulting from the inflammatory process. At first the blood in the diseased part is alone affected: this contaminated fluid passes away by collateral capillaries into the circulation, while fresh blood takes its place in the affected part. In time the whole volume of blood participates in the morbid changes. These changes, to repeat somewhat, consist in an increase of white corpuscles, which are perhaps altered; also a relatively increased number of red corpuscles, which are constantly undergoing changes perhaps of degeneration, or are

actually dying; and the fibrin possessing increased vitality is likewise increased in quantity. The blood is, by these morbid changes, rendered irritating, and, as it passes into every part of the body, it carries the seeds of inflammatory disease to be planted in tissues preternaturally weak, or otherwise predisposed to inflammation; and thus it is that through the agency of the blood inflammation may extend from its original seat to parts remote.

Absorption is another way by which inflammation may be said to extend. Apart from the network of capillaries is a system of nutrient vessels (cells, Virchow), by which, no doubt, nutrition is immediately carried on; and through which extensive territories, to which the capillaries approach not, are supplied with nutritive juice. Through these most likely are conveyed from the seat of disease, morbific elements, derived either from the blood or elements of the tissue. These may find entrance into the lymphatic system, and, passing along to the glands, be there arrested, to create disease; or perhaps, passing onward, ultimately to affect the mass of blood. A familiar instance of extension by absorption is afforded in the inflammation of the glans penis caused by specific poison. In this case the poison being absorbed, it passes to the glands of the groin, which, in the discharge of their function to keep back anything which is deleterious to the system, arrest the poison; and thereafter, in consequence, themselves become affected. In ordinary inflammation it is not so likely to extend by absorption as when the system is in a vitiated condition; because in such a case morbid elements are more likely to be formed within reach of the absorbents.

Another means whereby inflammation extends is *through the agency of the nerves.* We have discussed the subject as to the part taken by the nerves in establishing the inflammatory process, and it will be more easily understood how a morbid action of the nerves may cause the disease to extend. There are nervous centres; and, going from these, are nerves which divide into branches to be distributed to different parts. Now, when a part of the body is inflamed, not only the nerves thereof are deranged, but as well the nervous centre from which they immediately proceed. And more than that; other branches proceeding from this centre participate to some extent in the irritation. The action and reflex action of nerves are very well understood in health; but when the

action is morbid, when the ultimate constituents of the nerve-trunks are disarranged, the electrical condition thereof disturbed, the action of the nerves cannot be natural, and the reflex action is likewise unnatural. Also the various nerves arising and proceeding from the disturbed centre will sympathize in the general disturbance. Hence it is that a part supplied with nerves from a centre common to it and a part inflamed, is likely to become affected and inflamed. Hilton, in his admirable lectures on "Rest," has fully elucidated this question, to which reference will be more fully made in connection with diseases of joints.

These are the several ways by which the inflammation may extend from the part in which it arises: 1st. By continuity; 2d. By contiguity; 3d. By the blood; 4th. By absorption; 5th. By the nerves.

CHAPTER VI.

The Products of Inflammation: 1. Serum; 2. Liquor Sanguinis—Fibrin—Coagulation—Development—Hypertrophy, True and False—Atrophy—Induration.

HAVING considered the "*inflammatory process*," the *causes* of inflammation, the *symptoms*, and, in connection therewith, the *diagnosis*, the *prognosis*, and the course and terminations of the disease into either *resolution* or into further morbid displays by *extension*, and the several ways by which it may take place, we are fully prepared to investigate the several products of the disease, or the results of the inflammatory action. (Paget.)

It will be well to recall to mind the changes which take place in the capillary coats during the inflammatory process, a change from healthy nutrition to the existence of morbid products of diseased action. To illustrate, let us take a common cold in the head. The first indication is a watery discharge from the nose, or perhaps a dryness of the mucous membrane, causing a sensation of stuffiness. In reality, the first effect of the "cold" is an exalted action of the mucus-secreting glands, by which there is a copious secretion of

healthy material, only that it is more watery. When the vessels contract under the irritation the secretion is arrested, and the dry stage results. Thereafter, when the coats relax secretion again takes place; but it now is not only greater in quantity but also changed in character. Everybody has experienced a catarrh in the head, and can at once understand the illustration. The inflammatory process is identical in other tissues, only that instead of the effects being exhibited upon a mucous surface in the altered secretion of mucus, they present themselves in the transudation of abnormal material into the structure immediately around the capillaries; or, in other words, instead of transudation of those elements required for nutrition, there is, as a result of the inflammation, transudation of material which cannot become in any case elements of *ordinary* repair.

The first product to be noticed is *serum*. This may often be seen when there is only congestion, before the vessels have lost their tone; but it is when they become much relaxed that it more particularly abounds. Very often in what seems to be serum only there is a quantity of fibrin, which shows a tardy disposition to coagulate even when separated from the body. As a general thing, the quantity of serum is greater when the inflammation is more chronic, and when the action is acute, fibrin will preponderate. The exudation of serum from engorged vessels is no doubt a curative effort; the turgescence is often thereby very much relieved; and should the cause of irritation then cease to exist, the serum would very soon be reabsorbed.

The *second product* of inflammation—liquor sanguinis. This, it will be remembered, is composed of serum and fibrin. But the fibrin now receives another name. Changed in character, and probably increased in quantity, as a result of the inflammation, it takes the name of "inflammatory lymph." After transuding, the fibrin remains soluble in the serum for some time; but sooner or later it begins to separate from it, or rather the serum flows, or is pressed away by the coagulating fibrin. The length of time which elapses before it thus separates into its component parts—serum and fibrin—varies; it may take place at once, or it may not for some length of time; or a portion of the fibrin may become solidified while another portion remains in solution. In each event it is not difficult to observe an attempt to arrest disease or re-

store to health. Perhaps further observation will enable us to say that there is always an early tendency in a portion of it to stiffen around the small vessels, and thus by *external support* assist to prevent over-distension and paralysis; and further, by fixing the tissue, as it were, to secure a degree of *rest* which will favor recovery. Paget, as well as Virchow, has shown that a very long time may pass away while the fibrin remains in solution; indeed it would sometimes almost seem that exposure to air alone will cause the lymph to coagulate. Coagulation, it will be remembered, is the last act of life in fibrin when separated from the body, and in the main it must be considered the same when only without the blood-vessels; hence the unwillingness of nature, so to speak, to take a step by which the fibrin becomes in most respects a foreign body. While in solution, or only solidified in a limited quantity, it can readily be absorbed; but after coagulation, the process of absorption is necessarily slow. This property, therefore, possessed by inflammatory lymph, of remaining in solution for a longer time than natural fibrin does, is one of salutary importance, in so far as recovery is concerned.

Virchow, in his cellular pathology, states his belief that there is at all times two kinds of fibrin in the system,—one the fibrin of the blood, the other that of lymph; and that it is the latter which manifests this tardiness to coagulate. As yet we may feel some unwillingness to receive this doctrine; but should further experiments attest the truthfulness thereof, the important fact would still remain, that in inflammatory conditions the fibrin which so abundantly transudes is tardy in coagulating; and that, while the solidification of a limited quantity will prove beneficial by affording external support to distended capillaries, the fluid state of the greater quantity is one favorable to absorption, on the cessation of the inflammatory action. And still more, as we shall see when we come to describe the healing process, this fluid condition of the fibrin allows the formation of new bloodvessels to take place in its substance, whereby the coagulated fibrin is preserved from becoming altogether a foreign body, and by which it is afterwards gradually removed, as natural tissue is substituted for it. The sacculated and tortuous state of the paralyzed vessels may be considered a first step toward the formation of these new vessels. I

will risk being tedious, to endeavor to make this clearly understood.

Let us suppose lymph to have been effused between two capillaries (see diagrams, pages 28, 35), which are dilated, elongated, and sacculated. Now, suppose further, the inflammation to have been arrested, and the lymph and serum about to be separated; the latter to be absorbed, the former to attempt organization. Should the lymph coagulate all together, it will, in many respects, be a foreign body, and its removal be difficult, tedious, or impossible, unless by suppurative degeneration. If, however, this adventitious matter be supplied with vessels, then its removal will be more easily effected. Now it seems to be by those sacculated points that the first steps are ordered to form new capillaries which shall traverse the new material. These sacculated portions continuing to dilate and extend, become in time an offshoot of the vessel, and eventually meet another similar offshoot from either the same or another capillary. The meeting walls break down, and thus a complete channel is made through which the nutrient fluid at once begins to flow. The part which this new vessel plays is an important one: by it no doubt the life of the coagulated lymph is prolonged; and when it has served its purpose, as I venture to think, of fixing the tissue, and has lived its comparatively brief life, it is removed in the same manner as natural tissue after it dies or wears out. Perhaps it cannot with certainty be said that pseudo tissue, thus organized and sustained by blood, entirely fails to appropriate, like genuine tissues, from the blood, so as to perpetuate its existence. But if it possess such power it is very limited in degree, while the tissue in which it is placed will exercise a more potent influence in assimilating, so as eventually to substitute natural for the unnatural elements. Thus, while the temporary fabric is being pulled down, a natural structure will be erected. It is in this way that in course of time a part, in which has been, as a result of inflammation, an extensive deposit of fibrin, may be perfectly restored by a natural process of ordinary repair. There are several facts which go to support this view, to which reference will be made when speaking of the *healing process*.

Hypertrophy, True and False.—But instead of a removal being thus gradually and fortunately effected, quite a contrary result may follow. Although inflammatory action, it may be said, has

subsided, there sometimes remains a degree of irritation which is due to the adventitious matter before mentioned. On account either of the large amount of fibrinous deposit, or the restless nature of the tissue or organ involved, there is an absence of that condition of the part which is necessary for absorption to take place. Perhaps the coagulating fibrin within the part embarrasses its function; perhaps the function of the part is such as almost to preclude the possibility of that repose requisite for the material to be absorbed. The consequence of either is, that pathological irritation continues, and a continued determination of blood supplies more than is required. The transudation of liquor sanguinis steadily in limited quantity continues, the fibrin of which constantly undergoes changes heretofore described; and constant addition thus is made to the previously added deposit. From time to time there will be an exacerbation of the symptoms, and inflammatory action will take the place of the formative process; this will subside, yet recovery cannot follow, but a renewal of the formative process. Instances of this continued irritation may often be seen after inflammation of the conjunctiva. Here the constant motion of the eyeball, and probably the exposure of the eye to light, very much interferes with the removal by absorption of the products of the inflammation. When a tissue is increased in volume in this way it is the seat of *false hypertrophy*, so called in contra-distinction to that hypertrophy where the volume is increased by the addition of the *natural* tissue.

But this congestion may be followed by *true hypertrophy*. The irritation may constitute a "physiological stimulus," instead of a pathological one, and the result is that the part grows. Thus we see that one immediate product of inflammation may lead to other and remote products, namely, true and false hypertrophy; the former being characterized by the addition of tissue like the original; the latter by the gradual addition of organizable fibrin, which becomes intimately incorporated with the tissue affected.

Atrophy of Tissue.—Sometimes, however, instead of hypertrophy, true or false, resulting, atrophy supervenes upon the coagulation of the transuded fibrin. This can be understood when it is remembered that fibrin in process of coagulation and organization always contracts. Now, under certain circumstances, this contraction of the inflammatory lymph affects the nutrient vessels,

—capillaries and larger vessels. By pressing upon them, the necessary supply of blood is cut off, and the nutrient fluid is pressed out; nor can it thereafter enter as in health; so that there results a disturbance of that condition necessary for normal ordinary repair; the effect of which is that, in the first place, the tissue is pressed together, whereby its volume may be diminished; and, secondly, in time, from want of nutrition, the part actually wastes away, and atrophy is the sequel of the primary product.

Induration of Tissue.—This is not an infrequent result of inflammation. The plastic material, which has been effused, and which has become organized and incorporated with the tissue, occupies the interstices thereof; by the presence of which the tissue is made unusually dense and hard—indurated. This condition may exist alone, or in connection with either *false hypertrophy* or *atrophy*.

So far, in the consideration of inflammatory lymph, I have spoken only of those changes which exhibit attempts, more or less successful, to become organized, and to cure. But it has been seen that, instead of the efforts to restore being always successful, there frequently arises therefrom other pathological conditions, namely, *hypertrophy*, *atrophy*, and *induration*.

CHAPTER VII.

Products of Inflammation—Degeneration of Lymph—Corpuscular and Fibrinous Elements—Cause of each—1. Pus: How formed; Different ways found—1. Abscess; 2. Diffused; 3. Upon the Surface—2d Form of Degeneration of Pus—Fatty; 3d. Calcareous; 4th. Pigmental—Blood as a Product—Changed Mucus.

But inflammatory lymph does not always show this tendency to organize—to become developed. In consequence either of the intensity of the inflammatory action, or the state of the lymph itself, it sometimes degenerates—descends to a lower state of existence. As a result of inflammation, the most ordinary form of degeneration is into pus.

Inflammatory lymph may be divided into two kinds, one of which is characterized by a tendency to organize, and the other to degenerate into pus. (Paget.) Or I may say that the fibrin of the liquor sanguinis is composed of two elements: one is a fibrinous element, the other corpuscular. These may exist in equal proportion, or one may be in excess. *When the fibrinous element is in excess, there will be a tendency to organize, and a disposition to what is called the adhesive form of inflammation. When the corpuscular element abounds, the tendency to degenerate into pus will exist; this constitutes suppurative inflammation.* There are three conditions, to one or more of which the distinctive character of the fibrin may be due: 1st, the state of the blood; 2d, the character of the tissue involved; 3d, the intensity of the inflammation, or the exciting cause.

The blood of a healthy subject, in inflammation, always possesses more of the fibrinous element than that of one who is unhealthy; and especially of a scrofulous subject, or one whose system is reduced below par. And there are certain conditions of the system, or blood, in which the corpuscles are both numerous and susceptible of degeneration, whenever inflammation may arise.

In the second place, certain tissues, when inflamed, always produce fibrinous lymph; at least it is largely in excess; for instance, the fibrous tissues and serous membranes generally. It is one of the facts earliest learned by the student, that in inflammation of the serous membranes adhesions are likely to form between two surfaces which may come together. On the contrary, when the skin, or mucous membrane, or cellular tissue, is inflamed, the lymph resulting is composed more of the corpuscular element; and hence the fact that pus is a probable product of the disease, as in erysipelas, &c. When the lung is inflamed, in the resulting lymph these two elements are about equal; but Paget says that the corpuscles show a marked tendency to degenerate. In the brain, when inflamed, there is rather a tendency to the formation of corpuscular lymph.

I wish here to refer particularly to the interesting and important fact, one which will obtain more attention hereafter, that, in each tissue and organ of the body, such lymph is elaborated, in connection with the inflammation, as will best serve a curative purpose. (*Vide* Healing Process.)

In the third place; the intensity of the inflammation, to a certain extent, modifies the character of the lymph. The greater the intensity, as a general thing, the larger the proportion of the fibrinous element. This is equally true in all tissues, whatever may be the controlling influence they have as such.

One of the above conditions may modify another; while, if they all act in harmony, either to favor the formation of the fibrinous element, or the corpuscular, the effect will be correspondingly great. For instance, in diphtheritic inflammation, although a mucous tissue is concerned, yet, owing to the intense nature of the disease, the fibrinous element preponderates, so that a false membrane, such as forms upon serous membranes, is produced. On the other hand, when inflammation arises in the serous membrane of an unhealthy person, or when the inflammation be asthenic, then, instead of adhesions taking place, pus may be expected to form, indicating a want of the fibrinous constituent of the lymph. Such, then, are the circumstances which give to the inflammatory lymph either a fibrinous or corpuscular character. And it is well to remark here, that these circumstances must be duly taken into consideration, when the surgeon is called upon to form a *diagnosis* and *prognosis*.

Pus.—As before said, the most frequent form of degeneration of lymph is into pus. This fluid presents the following characteristics. It appears to the naked eye as a creamy, thick, opaque,

and homogeneous fluid; communicates an unctuous feeling when rubbed between the fingers; is a yellow or whity-yellow tint; sweetish, or insipid; and, while warm, gives off a peculiar, mawkish smell. Its specific gravity is 1030–1033. If allowed to stand some time in a tall, narrow glass, the fluid separates into a thickish *sediment*, more or less abundant, and a supernatant *serum*. This serum, according to Vogel, is identical with the serum of the blood, containing much albumen, extractive and saline matters, and fat. The reaction is alkaline; but it readily becomes acid, from the generation of an acid, which is commonly supposed to be the

lactic. In some cases, however, according to Walshe, it has an acid reaction even at the time of its formation. "The sediment consists almost entirely of small organized corpuscles, the well-known pus-globules. These are of spherical form, have a well-defined contour, formed by a distinct homogeneous envelop, inclosing a soft, granulous substance, and a varying number of nuclear corpuscles. These are, in well-formed pus-globules, for the most part concealed by the surrounding substance; but, in the younger cells, even of healthy pus, and in all those of pus of an inferior kind, they are easily perceptible, even without the aid of acetic acid. Occasionally, a single nucleus exists; bnt more commonly it is made up of two, three, four, or even five large granules. The single nuclei are always the largest, and indicate, as we conceive, the most perfect kind of development." "The nucleus is seated on the envelop, or is parietal, as it is termed. Its diameter is about $\frac{1}{6000}$ in.; that of the entire pus-globule about $\frac{1}{3000}$ in." (Jones and Sieveking's Pathological Anatomy.) Paget calls the liquid in which the pus-cells are suspended the *liquor puris;* and remarks, that "in the pus produced during healthy granulation, no other materials than these may be found." "But, often, minute clear particles, not more than $\frac{1}{10000}$ of an inch in diameter, are mingled with the pus-cells, to which they seem to have some relation as rudiments. And when the process deviates from health, we find not only variations in the pus-cells, but multiform mixtures of withered cells, molecular and fatty matter, free, or escaped and shrivelled nuclei, blood-corpuscles, fragments of granular substance like shreds of fibrin, and other materials. All these indicate defects or diseases of pus." "A caution is necessary against a very possible error which even practised observers have committed, viz., that of mistaking the colorless corpuscles of the blood for pus-globules. The two bodies are very much alike, but the blood-corpuscle is somewhat smaller, generally more finely granular, and with rather less definite contour. The interior nuclei of both are identical." (Jones and Sieveking.) But Virchow says that "we can never say with certainty off-hand whether we have to deal with colorless blood- or pus-corpuscles."

Such are the characteristics of pus, as observed with and without the aid of the microscope.

The circumstances which attend degeneration of lymph into pus,

or which turn the process from organization into one of degeneration, may now be more fully considered. It will be remembered that it is a prerequisite for development and organization of lymph to have a cessation of the inflammatory action; and furthermore let it be stated that the inflammation must not have been in active progress beyond a certain time, which length of time will vary according to circumstances hereafter to be fully described. But, if the exciting cause of the inflammation continue to act, then there is entered upon a new stage of the disease, another step in the inflammatory process is taken, and what has been called *true* inflammation is attained.

Following the stagnation of blood and the free exudation of liquor sanguinis, there is, in the part immediately concerned, instead of coagulation of the fibrin and a squeezing out of the serum, quite a different procedure manifested in this fluid. The corpuscles of the fibrin undergo perhaps, I might say, a retrograde development; in reality, it is a degeneration. In this change the fibrinous element of the lymph participates. The palpable evidence of this change is the existence of the cream-like fluid pus, instead of the plastic buff-colored fibrin. Before degeneration sets in, perhaps a separation more or less complete had taken place between the fibrin and serum. Indeed, there is proof that a large quantity of lymph may simply coagulate, and remain so for even a few days, and then degenerate. In this latter case there is evidently a liquefactive, so called, degeneration. Take the surface of a wound when adhesion has failed to take place; after a few days it will be found covered with pus. Again, take a hard swelling due to extensive effusion of lymph which has coagulated; it is at first hard and unyielding, but in a limited number of hours, as every observing surgeon has seen, this hard swelling will have become soft and fluctuating. That which was solidified lymph is now a fluid pus, and that without the addition of any fluid fibrin. While this degeneration of inflammatory lymph into pus is in progress, the cause of the action continuing, the inflammation is extending, and where a short time before was congestion, is now stagnation; and more remote parts not previously engaged will now be rapidly beginning to participate in the morbid action. The symptoms which generally characterize the formation of pus will,

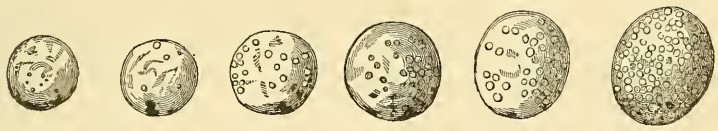
in another place, be considered, as well as the treatment to be pursued.

It has been shown that in the organization of lymph there is displayed a wise and salutary effort on the part of nature to repair the injury which the part had sustained, the cause of the disease having been removed. And also, when pus is generated, although it is a degeneration, a process with a tendency directly opposite to that of organization, yet it is nevertheless a means equally wise to effect a cure. The disease having lasted for a longer time, and the effects having been correspondingly aggravated, other and more complex steps are required to restore the part, and even more than this, to prepare the way for successful restoration. It is a necessity that the cause of the disease should be removed; and when, for instance, that cause is the presence of a foreign body in the tissue, then the formation of pus and the subsequent softening of tissue has the effect of opening a channel by which the foreign body will be expelled. It is nature's method of getting rid of a foreign body, a process to which I shall have hereafter to refer. Again, when pus forms upon the surface of a wound it constitutes the most suitable covering, one, indeed, which cannot be imitated, to allow the healing, which will take place by granulation. And again, when it is seen upon a mucous surface, it will be found to protect that membrane from irritation, to some extent, at least. And lastly, although the pus may not be required for any of the above-mentioned purposes to act as a remedial measure, yet, as lymph which has been transuded, and which is incapable of removal by absorption while in that condition, it pursues the next best course to make its exit from the body, and consequently undergoes a liquefactive change. Being found in the form of pus, it may, by pressure, cause absorption of the tissue, and find its way gradually to the surface, and escape in a bulk, or it may, under favorable circumstances, be absorbed. The precise method by which the former takes place will be dwelt upon in connection with abscess. The method adopted to secure absorption of the pus-matter will now be briefly noticed.

Pus as such cannot be absorbed; the cells are bodies of too large a size to be capable of entering the absorbent system. It is, therefore, necessary for some further change to take place be-

fore this product of inflammation can be removed by the process of absorption.

In the process of degeneration it has been observed that the corpuscles, which in the lymph were like the white corpuscles of the blood as well as the primordial cell, begin to increase in size. They "present a gradual increase of shining, black-edged particles, like minute oil-drops, which accumulate in the cell-cavity, and increase in number, and sometimes in size, also, till they nearly fill it. The fatty nature of these particles is proved by their solubility in ether, and their accumulation is attended with a gradual enlargement of the cell, which also assumes a more oval form. Moreover, while the fatty matter accumulates, the rest of the contents of the cell become very clear, so that all the interspaces between the particles are quite transparent; and, coincidently with all these changes, the nucleus, if any had been formed, gradually fades and disappears, and the cell-wall becomes less and less distinct." (Paget.) Finally, the microscope can no longer detect the



cell wall; indeed, it is dissolved, or has undergone such changes as will permit it to be taken away by the absorbents. These manifestations of nature are not only interesting, but they indicate as well in many respects the course of treatment which has to be pursued by the surgeon in the different stages of the inflammatory process.

Different ways in which pus may be found:

The 1st. In the *form of an abscess*, in which case it is circumscribed.

The 2d. When it is *diffused in the tissue*, and without any definite boundary.

The 3d. When it is poured out upon a free surface, as the skin or mucous membrane. (Paget.)

The peculiarity of each and the treatment will be taken up in due time.

While degeneration into pus is by far the most frequent in oc-

currence, there are others which require our attention. Both the fibrinous and corpuscular elements may undergo several forms of degeneration. The first is where they wither, become dry, hard, horny, the cells "are collapsed, shrivelled, wrinkled, glistening, and altogether irregular in size and form." (Paget.)

The second form of degeneration is, where an essentially fatty change takes place. In the fibrinous portion will be seen gradually collecting minute drops of oil, and the corpuscles undergo a transition into what is called granule-cells, or the inflammatory globules of Gluge. "This method of degeneration," says Paget, "appears peculiarly apt to occur in the inflammations of certain organs, as especially the lungs, the brain, and spinal cord; but it may be found occasionally prevalent in the lymph of nearly all the other parts, and in the granulations forming the walls of abscesses or of fistulæ."

The third form of degeneration is the calcareous. It is occasionally seen in the arteries and veins.

The fourth is called pigmental degeneration; sometimes observed in the product of peritonitis.

Having considered the character of inflammatory lymph, and the widely different changes which may mark its history until it ceases to act a part in the economy, I will proceed in the consideration of the products of inflammation.

Blood as a Product of Inflammation.—This may be regarded rather as an accidental product than as a constant one, except, perhaps, in pneumonia, in which disease it is almost always present, and gives to the sputa the characteristic rust color. But at any time after the coats of the vessel have become paralyzed, they may be actually ruptured so as to allow the blood to be extravasated. It must be distinctly understood that a red corpuscle cannot get without the vascular system, unless there is a distinct rupture of the coats. The transudation may be even highly colored,

but it is due to the coloring matter of broken-down corpuscles which has transuded with the serum. Again, in the attempt to form new bloodvessels, the offshoot may burst and the blood escape into the organizing fibrin. So it will be seen that in general inflammation it is but an accidental product. With regard to treatment, it requires no particular consideration.

Changed Mucus as a Product of Inflammation.—When inflammation arises in a mucous membrane, as already stated, the natural secretion is at first exalted and then suppressed; subsequently, in returning, it is quite altered in character and quantity. In addition to the mucus is seen, under the microscope, epithelial particles, more or less degenerate, and "materials which closely resemble, if they are not identical, with the lymph-products of inflammation in other parts. I am, indeed, disposed to think that we should not draw too strong a contrast between the inflammatory products of mucous membranes and those of serous membranes and other parts, except in relation to the material with which in the several cases they are mixed." (Paget.)

The foregoing are the immediate products of inflammation. There are other surgical affections which are often designated products also; these are *ulceration*, *sloughing*, and *gangrene;* but they, with other diseases, will be treated under the head of *Diseases arising out of Inflammation.*

CHAPTER VIII.

Treatment of Inflammation—In its First Steps—1. Nature as a Guide. 2. Prevention of Further Progress. 3. Sedatives. 4. Cold. 5. Heat. 6. Stimulants. 7. Astringents.

THERE are two things which ought to be constantly borne in mind by the surgeon in the treatment of this disease; the first of which is, that in the inflammatory process itself, and at each step of the process, nature seems to be making efforts to cure, and that many of the phenomena of the disease are results of those efforts. To this subject I beg leave to direct especial attention. Writers

on surgery have been accustomed for so long time to speak of the phenomena of inflammation, and indeed of all surgical affections, as purely *symptoms of disease*, that it is next to impossible to disassociate the indications therefrom, and to regard them instead as exhibitions of the admirable workings of nature to stay disease, to remove the cause thereof, and to effect a cure. I have thus far, in considering the inflammatory process, taken occasion, from time to time, to point out these kind doings of nature. And unless the student starts with the perfect understanding that he can only assist nature, and that in all he does he should take counsel with her, and follow her superior guidance, he will not, I unhesitatingly affirm, be prepared to render that wise and judicious assistance which enlightened surgical science justly expects at his hands.

The second point, and one of almost equal importance with the above, is to endeavor to have a distinct understanding as to the stage of the inflammatory process at the time he is called upon to treat the case. This is so obviously necessary that it may be deemed useless to refer to it; yet I am sure it will be found that some writers and many practitioners treat inflammation without any reference to this consideration. Having diagnosed the disease as that of inflammation, they proceed to treat it according to prescribed rules, forgetting, in their routine practice, that the treatment suitable for one stage of the process is quite unsuitable for another; that what may be a remedy one day may upon the next aggravate the disease. Now these two considerations, I think, stand foremost, and ought never be lost sight of.

The next thing for the surgeon to consider is, How much can I do to *prevent* disease? Indeed he may now and then be called in at a sufficiently early hour to be able to break the chain which leads from the exciting cause to the first stage—before physiological action has been superseded by pathological; or, if the disease has already been established, he may yet succeed in averting the second or some succeeding step in the inflammatory process. Then he will ask himself the question, What are nature's efforts under the present circumstances, and how far can I assist her?

To a just appreciation of the case, and in order to arrive at correct conclusions concerning the foregoing questions, a knowledge of the individual constitution will be indispensable, and should as far as possible be obtained. As well, and of equal importance it

is, to ascertain what were the predisposing and determining causes of the disease and the relative importance of each. In connection with this, the surgeon should duly weigh the circumstances of the patient and the evils connected therewith which he will have to combat, and to what extent can be secured that rest of mind and of body which will so much conduce to a favorable termination. It will also be desirable to consider what are his surroundings, his position, will he have good nursing, comforts, necessaries, and what are his desires and his degree of contentment.

The primary cause of the disease will not always receive the first attention. When constitutional, it will always receive, however, an early attention; but when it is local, it may already have passed away. The great, the chief thing is to get at the *cause* of the *continuance* of the inflammation, the principal *acting cause* of *extension* of the *disease*, and to attack it.

Instead of taking one by one the various medicines which may advantageously be used in the treatment of inflammation, it will, I think, be preferable to commence at the beginning of the "process;" at least at that point where nature is yielding to overpowering influences.

Imagine, then, an affected part, into which the blood is rushing with increasing force. The small vessels are engorged to such an extent that over-distension has almost resulted. They have dilated to receive the increased flow of blood, but the rush has been too great, and a contraction has followed more or less spasmodic. Then follows a relaxation, and again a contraction, although less powerful. And now they have almost lost their tone, stagnation of blood has almost resulted, and, should it ensue, inflammation will be really established. Now, under such circumstances, what can be done to avert it? Of course, if possible, the exciting cause should at once be removed. But the first class of remedies which I will notice as suitable to this stage of the inflammatory process is

Sedatives, as a remedy for inflammation.—These will first receive attention, because it is through the agency of nerves that the healing process is consummated. And sedatives may have the effect of soothing the irritated nerves, whereby an essential link in the chain of morbific causes may be broken. It is by irritation of the nerves that the pathological condition is initiated, and it is by their disturbance and from the pressure made upon them that

the pain is continued and the disease extended. Therefore, to soothe them at any time is to remove the most important means of disease. By so doing we are only imitating the efforts made by nature to relieve irritation by fixing the parts involved so that they may be in a state of repose. There can, indeed, be but little doubt that the tendency to adhesion which characterizes inflammation of the serous membranes is, by preventing motion of the irritated parts, calculated to secure *rest*. It is a fact most important to know that a full dose of opium will often arrest inflammatory action in the abdomen by securing *rest* to the viscera; and thus will nature, when unassisted by art, attempt, by forming adhesions, to obtain the same thing.

Anything which will alleviate irritated periphery, or pressed-upon nerves, will tend to effect a cure. If the part be kept at rest much is gained. But there are agents which will, often against great obstacles, assist in securing the desired end. The first sedative to be mentioned is

Cold.—It is generally applied to the part in the form of cold water, and it is a most valuable remedy, not alone because of its actual virtue, but, as well, because it is so easily obtained. Extreme cold is a powerful sedative, especially when applied with diligence. If applied to a part in health it will interfere with nutrition; and, when applied to an inflamed region, it will lessen the morbid action therein. The object is to lower the temperature of the part not simply to that degree which is natural, but to a degree even below it. The coldness of the water and the evaporation act together in securing this reduction of temperature. To carry out this indication the water must be very cold, or there must be such an arrangement as will favor evaporation, and, if possible, both. The following method of applying cold I can, after not a little experience, strongly recommend. Take a piece of thin old cotton or muslin, folded only once, and, having dipped it in a vessel of cold water, apply it to the part. It will be necessary, according to my own experience, to give very explicit instructions to the nurse about the cloth, as to thickness, &c., otherwise most likely there will be used a piece folded several times. And this, instead of being frequently dipped in the water, will be allowed to remain for a long time. The result will be a steaming cloth upon the inflamed part. Such an application may, it is

true, prove beneficial as a vapor bath, but not as a cold application. It is necessary to have the cloth thin to allow free evaporation. Just as soon as the cotton has dried or its temperature raised to that of the body, it ought at once to be reapplied. In those cases where the inflammation coexists with a wound, the disturbance of the cloth will irritate the wound; consequently, instead of dipping the cloth in water apply the water with a sponge or another piece of cotton, allowing it to drip upon the part. In this case, however, the attention will have to be more diligent. The vessel of water must frequently be renewed, or the water have ice in it.

A part may be kept wet and cold by irrigation, but this cannot be done without some difficulty; moreover, the continued dripping is likely to be attended with discomfort from the water running into the bed or into the clothes of the patient. Another objection to irrigation is, that unless used with constant caution, there is great danger of reducing the temperature too much, so as to destroy vitality of the tissue. There are other methods sometimes recommended, but as I, in the main, refer only to such as my own experience has proved worthy of recommendation, I may be pardoned for omitting them. There is, however, one other method which I wish to dwell upon for a brief time.

In the winter of 1863–4 I had the opportunity, when on a visit to the United States Military Hospitals in and about Washington, of witnessing what was to me quite a new mode of applying cold, never having seen it nor heard of it before. It consisted in the application of ice to inflamed parts arising from gunshot wounds of every kind, a piece of cloth folded two or three times intervening. I was assured that inflammation (and these wounds are generally followed by a good deal of inflammation) was, when taken in time, to a great extent prevented, and when it had arisen was often quickly and effectually subdued. Subsequently, during the following summer, when, for a time, holding an appointment in the United States Medical Service, and doing duty in the Lincoln Hospital, Washington, I availed myself of the chance of testing what I had felt sure was a most excellent practice. In the vast majority of cases which came under treatment in that Hospital, and indeed in all the hospitals of Washington, some time had elapsed from the time of receiving the wound until the entrance

into the hospital. Much inflammation had arisen, yet in every case, whether the wound was in a limb, or in the chest, or the abdomen, or the head, the application of ice in the manner above stated had a most decisive effect. But I had the most favorable opportunity of trying its effects upon a large number who had been recently wounded, who indeed were transported to Lincoln Hospital within twenty hours of the time of being wounded, and who had received no previous treatment whatever. They belonged to the cavalry force, and had been wounded in the afternoon while engaged with a similar force of the enemy at Beverly Ford, and they reached the hospital about four o'clock the following morning. I happened to be the officer of the day, and many of them were placed under my own immediate care. Among a comparatively large number under my own care, and as well as of other surgeons, all of which I carefully watched, there were wounds in every part of the body. In every case where the ice treatment was pursued the result was the most happy, and, in some cases, beyond our most sanguine expectations.

The principles upon which this treatment is based are most reasonable. By means of the ice the temperature is constantly maintained at the same degree. It can be regulated by changing the degree of thickness of the intervening cloth, rather than by the size of the piece of ice. Another advantage is, that the patient requires a less constant attention; and if depending upon a negligent nurse he is less likely to suffer therefrom, inasmuch as a piece of ice will last a much longer time than a wetting with cold water. There is but one objection, which is, that the melting ice will in time make the patient uncomfortable. But this can be easily remedied by putting the ice in a bladder, or a bag made of oiled silk or gutta percha.

Heat is also a sedative, and in the form of hot fomentations is very useful. It likewise acts upon the irritated nerves. The soothing effect of the heat is increased by the moisture. One is directly sedative, the other indirectly so. The heat immediately affects the nerves; the moisture, by relaxing the distended tissue, lessens the pressure upon the disturbed nerves, and thus begets relief. Thus we see that both heat and cold, used in the form of water, are useful remedies in inflammation; and, indeed, either might prove beneficial in the same case, perhaps almost equally

so. However, some tissues and organs seem to be more speedily and surely affected by the one than by the other. For instance, in surgical affections of the head, cold is by far the most serviceable; while in like affections of the abdomen, hot fomentations will be found to act the most promptly; but I must not omit to mention, with regard to the latter statement, that some German writers assert that, although the cold when applied to the abdomen is less pleasant, yet its effects are all that can be desired. From observation and from personal practice, I feel bold to say that hot fomentations should always be used in inflammations of the abdomen.

As a general thing, the feelings of the patient may be consulted and followed as a guide. In the eye particularly, it is found that an inflamed conjunctiva will, in some instances, be relieved by a cold wash, while in others the irritation is thereby increased, yet it will be benefited by a warm collyrium.

There are various sedative *drugs* which may be employed as local applications or administered internally, such as opium,—a most valuable one,—aconite, belladonna, colchicum, &c. Two or more sedatives may be used conjointly, as opium with warm fomentations, in the form of poppy-head fomentations.

Stimulants.—Strangely enough, while sedatives are so very useful in breaking the chain of morbid events in inflammation, at almost every step of their progress, stimulants are also, at least in one stage of the disease, of like service. When it is remembered that in acute inflammation there is too much action—too much irritation—it would seem that stimulants must certainly be contra-indicated; yet experience has proved their efficiency, while theory will be found to fully support the practice. I will adduce a few common instances, in which stimulants have in practice been found decidedly beneficial.

A common cold, inflammation of the Schneiderian membrane, is often relieved by the use of snuff, which stimulates the tissue, although already over-congested. Again, if the "cold" affects the mucous membrane of the bronchi, it may be, sometimes, promptly relieved by a hot, stimulating drink at bedtime. Congestion of the liver is frequently cured by a calomel pill, which stimulates that organ. Conjunctivitis is often cured by a stimulating collyrium, and an inflamed throat by a capsicum gargle.

These are instances of a similar nature. This is the successful practice.

Now, how may it be explained theoretically? Fortunately, very easily. According to Paget, when a frog's foot or a bat's wing is placed under the microscope, is irritated until the phenomena of inflammation begin to present themselves, and paralysis of vessels is almost accomplished, a renewed effort to contract may be provoked by increasing or varying the irritant, as if departing life were brought back by the increased irritation. This renewed or increased contraction of the coats causes the blood, which was moving so sluggishly, to pass on with a perceptible increase of velocity, whereby the stagnation is delayed, perhaps averted. And no doubt the same events would be seen to transpire, could the tissue in the human body be similarly inspected under like circumstances. The stagnation of the blood marks the establishment of disease, and anything which will delay it, cannot but be regarded as a remedial measure. Thus we find that practice is supported by theory.

But while stimulants do undoubtedly prove very often remedial in their effects, the use of them must be considered hazardous unless administered with great caution. Bearing in mind the pathology of inflammation, and the *modus operandi* of stimulants, it will easily be understood that, if they fail to do good, they necessarily aggravate disease. I would not, therefore, be understood to recommend the indiscriminate use of stimulants as a local application in the treatment of inflammation, nor would I have them placed alongside of sedatives or astringents, which I have next to notice.

Astringents.—The effects of an astringent medicine upon the mucous membrane of the mouth, for instance, is well understood. There is a sensation of puckering—of drawing together of the tissue. When applied to the skin the effect is the same, although not so appreciable. At all times, this drawing together of the tissues will necessarily tend to press out of the interstices the fluid therein contained. In inflammation, when the coats of the vessel are beginning to succumb to the pressing blood, an astringent, by virtue of external pressure which it gives to the tired-out coats, will assist to force onward the sluggish stream of blood. At the same time, any fluid which may have transuded into the tissue,

will stand a chance of being pressed out of the part by being brought into contact with acting absorbents. In this way, by the calibre of the vessels being diminished, and the blood forced away from the part, the equilibrium will often be restored. No effusion had taken place which cannot be absorbed, and the disease, which may have been most threatening in its appearance, is averted, or cured, simply by the application of an agent which made gentle pressure by its physical effects upon the tissue.

Foremost among the astringents suitable for the treatment of inflammation, as well as among the sedatives, is cold water. Its virtue as a styptic will be pointed out in connection with the treatment of hemorrhage. Possibly the astringent action follows the sedative; but whether this be so or not, its properties as an astringent are satisfactorily established.

Plumbi acetas is a most valuable medicine of this kind. The powder dissolved in water, in the form of Goulard's Extract, is the way in which I generally use it, and in good strength. To it may be added some preparation of opium. Having used this almost exclusively as a local application in inflammation for many years, I feel that I may speak *ex cathedra*, and say, that when diligently used it will never disappoint the surgeon, and that I know of nothing that can take its place. I am aware that it is no new remedy; but in this day of change and of forsaking of old remedies to try new ones, there is a possibility of neglecting a useful thing for the novelty of the untried. It seems to be somewhat sedative as well as astringent.

Thus far, in speaking of remedies, reference has been made to that stage of the inflammatory process where the disease is not fully established. But it must be understood that, after the disease is in all respects established, the same remedial agents will continue to prove useful; for, although the district in which the disease has arisen may have passed into a state of "true inflammation," there will be in the parts surrounding it the same condition as had previously existed in the former part.

I proceed next to speak of evacuants.

CHAPTER IX.

Treatment continued—Evacuants, including Derivatives, Emetics, Purgatives, Diuretics, Diaphoretics—General Bleeding—Direct Evacuation of Blood—Cupping—Leeching—Puncturing—Counter-irritants—Rubefacients—Pressure.

THESE, for consideration, will be divided into *local* and *general*, or those which draw off fluid from the part directly, and those which accomplish the same end by acting upon the general system. The latter I will speak of in the first place.

Those which act through the system are *emetics*, *purgatives*, *diuretics*, *diaphoretics*, and *bleeding*.

With respect to *emetics*, some doubt may reasonably be entertained as to their being beneficial in inflammation. When food has been taken into the stomach and will not be digested, or, if so, will be very imperfectly done, and which will consequently enter the system as a crude irritant material, and not as a nutriment, then the administration of an emetic, to cause the stomach to eject it, will prove highly beneficial; but when such is not the case (and it must be admitted that such instances are very rare, for the patient does not become so suddenly ill,—is not likely to have been eating in large quantities so recently), then an emetic is more likely to prove injurious than beneficial. The fruitless retching and straining is painful and exhausting, and will be followed by great reaction, which will in turn affect all parts of the body. If the depression were maintained, benefit would result; but emesis followed by reaction is only evil, with the exception before stated. When there is nausea it may as a general thing be looked upon as intelligent information that there is in the stomach, ingesta which the system refuses, and consequently an emetic may be given.

While the use of emetics may be questioned, the employment of *purgatives* is always useful in the treatment of inflammation, unless the action of the bowels will, because of contiguity, increase the irritation; the disease existing in the abdominal region. In most

cases they afford the most important benefit, and cannot be overlooked. The bowels are mostly always constipated (*vide*, general symptoms). The dry state of the mucous membrane of the intestinal canal, the arrest of secretion by the liver and other glands, causes a retention of the fæces, which becoming dry and hard, prove a source of irritation to the constitution. The prompt and complete removal of this substance will prove salutary, inasmuch as the total amount of constitutional irritation will thereby be lessened.

But particularly the purgative will arouse to action the glands of the intestinal track, by which copious *evacuations* may be secured of watery material, in which will be found a certain quantity of albumen, by the means of which the richness of the blood will be lessened. The derivative effect obtained in this way is very considerable. The total surface of mucous membrane from which secretion flows is said to be about 1400 square inches (Meckel); and if excretion continue therefrom for any length of time the blood will be materially affected.

In addition there is the *counter-irritation* and *counter-congestion*, by which nature is diverted, to a very great extent, from the seat of inflammation. Practice will show that very decided and important relief can be obtained by the judicious exhibition of purgatives in acute inflammation, with the exception above referred to, when the inflammation is located in the abdomen.

Diuretics.—When inflammatory fever exists, the kidneys are unable to perform their function; the increased tone of the vascular coats affects these organs in common with other parts. The urine is therefore scanty and highly colored. In the water which does transude through the tubules there is a large quantity of urea. Now, if the kidneys be not themselves affected, it is at least desirable to bring about a more healthy action of these excreting organs, so that all the urea will be eliminated; and often the system or blood may be relieved of a certain quantity of fluid. Moreover the increased action of the kidneys is a counter-irritation.

As it is not my object to dwell upon individual medicines, unless such as I have fully tested, I will be pardoned if I only allude to one. All the preparations of potassa are valuable; but I have found, as is often the case, the most common to be the most useful; that is, the nitrate. I do not know that my treatment in this

respect is very extraordinary, unless in these respects, that I trust to potash alone, and give it in large doses and every hour, as long as there is fever. The object in view is to start the kidneys; but I think that more than this is to be accomplished. As is well known, the blood itself is beneficially affected; of this, however, I shall speak hereafter. I have noticed, in addition, that the action of the heart is very soon diminished; that increase of tone in the whole vascular system seems to be lessened; in a word, there is, in a comparatively short time, a great abatement of the fever. So well has this drug answered my expectation, that I now always give it when there is heat of skin with an increased pulse.

Diaphoretics are also a very important class of medicines in the treatment of inflammation. The skin is dry and hot; the pores are closed; excretion of effete matter, which normally takes place from the skin, has entirely ceased. To relieve this unnatural condition, induced by the inflammatory action, and itself an additional cause of inflammatory action, diaphoresis should, as speedily as possible, be produced; so that the material ordinarily eliminated by the skin shall no longer be retained in the system, and so that the integumentary vessels shall be relieved. Nitrate of potash, of which I have ventured to speak so highly, will serve a good purpose as a diaphoretic. I have, in cases of inflammation of important internal organs, found the veratrum viride to act both upon the heart and skin. Regarding this medicine, I shall have something to say hereafter in connection with a case of gunshot wound.

Bleeding is the next agent to which I desire to direct attention. Concerning this mode of evacuation, or depletion, a very great difference of opinion may be said to exist, and to have existed for some time past. In the blood are the elements of nutrition; it is the tissues' food. For the welfare of the tissues it is necessary that blood should exist in a state of nature. No more normal, true blood, is produced than nature requires. In the system is no laboratory in which a larger quantity than usual of blood can be expeditiously manufactured on demand. On the contrary, it seems to grow, to be gradually developed. And more than this, continued development of blood depends, not simply upon the introduction of aliment, but especially upon the blood already in existence. Speaking somewhat roughly, the young blood is the offspring of the old. If the old be destroyed, removed from the

body, of course it can no more beget offspring. Therefore, after abstraction of a quantity of blood, that which remains will be wanting in strength and vitality, and the tissues depending upon it will become sufferers. More than this, after inflammation, repair will have to be made in the part which had been affected; so that, in addition to ordinary repair, blood will be wanted for this extraordinary repair. Now, whatever may be the elements of the blood required for each of these processes, it matters not regarding this question. When blood is taken from the system, in the main all the elements of the fluid are common sufferers. Therefore I unhesitatingly assert that, as a general rule, other modes of treatment ought to be sought. But many, I doubt not, are ready to say, "Granted, that abstraction of blood is followed by evils, where is your substitute; for the testimony of hundreds speak in its favor?" Let us examine the matter. Bleeding has been practised for, or may be resorted to for one of two purposes, either to draw off blood from an inflamed region, or to cause sedation; that is, to take blood until syncope is produced. Well, if the object be to draw off blood from an affected tissue or organ, the rational question presents itself, cannot this be done with equal efficacy without taking the precious fluid altogether from the system? In reply to this I would say, not only that it can be accomplished as well in another way, but even better. Local abstraction of blood, while it directly relieves the part, does not to a material extent affect the whole volume of blood,—does not diminish its vitality; and therefore will not retard the curative efforts of nature, nor subsequently affect the well-being of the patient.

"But bleeding," say some, "is often necessary to produce speedy sedation." At times, undoubtedly, when an important internal organ is involved, the integrity of that organ, perhaps life itself, may depend upon a quick reduction of the heart's action. And when such is the case, when the surgeon or physician has been called in at the eleventh hour, and no medicine can be found to do the pressing duty, then by all means open the vein of the arm, and allow the blood to flow until syncope ensues. In inflammation of the brain, lungs, liver, &c., such urgent cases may occasionally be met. Here the surgeon has to exercise a choice. Of two evils he will choose the least. Doubtful whether he can command medicines to control the heart's action as speedily as is ne-

cessary, he escapes the immediate danger by incurring the risk of one that will follow. When bleeding is practised in these urgent cases the relief experienced is generally well marked. There is not only sedation, but the organ is relieved, the quantity of blood within it is promptly lessened; but, unfortunately, this does not continue. The depression will naturally be followed by a reaction; the heart, momentarily reduced in action, will very soon rise to its former inordinate activity or perhaps to a greater. The volume of blood within the vascular system was for a brief time reduced; but it was soon restored, not by true blood; but to supply the place of the vital fluid which has been removed there will be taken up from the tissues such juices as come in contact with the absorbents. (Hence the sensation of thirst after bleeding.) And the consequence is that into the part inflamed again rushes the blood; but now it is more watery; and truly the last state of that part is worse than the first. From this consideration we may learn that, in order to maintain the reduction of the heart's action, a second bleeding may become necessary; and such is the practice still adopted by some. For this procedure there can be no proper argument advanced and no excuse given, unless indeed it be in the backwoods, where medicines are not to be had, or when unexpectedly the surgeon finds himself destitute of such medicines as are required. As a general thing, and I say it with due consideration, although a first bleeding *may* be imperatively demanded, a second one can never become necessary if only proper medicines are administered to produce sedation. There is one other thing to be mentioned in this connection, namely, that when the lancet is used the patient ought to be in the upright position, so that the desired effect may be produced with the least possible loss of blood.

Local Bleeding.—I have said that local bleeding will, in most cases, more effectually draw off blood from a part than will general bleeding. The blood may be actually abstracted from the body, or it may be drawn to a neighboring part, where, being retained for a time, the affected tissue is enabled to recover its tone before stagnation of blood takes place; or, if "true inflammation" exist, to take on a physiological action. The advantage of this latter is manifest. One of the objects even of general bleeding is obtained, drawing away the blood; yet that fluid remains in the system, and

although it was imprisoned for a while, it, as soon as released, starts again on its course of circulation. This treatment is often practised in the form of *dry* cupping. By their application a quantity of blood may be collected in a part for a certain length of time. We have here not simply a plausible hypothesis, but sound principles of practice. I speak from considerable experience, derived from hospital practice when house surgeon, and also from private practice; and I must say that I have often, in treating congestion and actual inflammation of the lungs, instead of using the lancet, *a la mode*, covered the chest with cupping glasses, and have been surprised at the great and prompt relief that was thereby secured. Dry cupping is equally salutary oftentimes when applied to the back in spinal complaints; and to the neck in inflammation of the brain, &c. But I have referred especially to the case of the lungs, because in this, I think, more than in any other, general bleeding is occasionally really demanded. The practice of drawing blood to a part, and retaining it there for a time to relieve inflammation, is not new, nor is it confined to any country. Some years ago an ingenious Frenchman invented a glass vessel in which to place the leg, and then, by exhausting the air in it, caused blood to occupy the leg to an inordinate extent. This was done to evacuate blood from an engorged lung.

Now I wish to repeat that my humble opinion, based on the varied experience which I have had the opportunity to acquire in American and English, as well as in Canadian practice, is, that bleeding is rarely necessary,—that, for the purpose of evacuating an inflamed part of blood, cupping, very often dry, and if not wet, will be fully adequate to meet the requirements,—will, indeed, in that respect, accomplish as much as would general bleeding; and that, for the object of producing sedation, we have available other means, not objectionable, yet quite as certain, and almost as speedy. (*Vide*, remarks on veratrum viride, &c.)

The terms *wet* cupping and *dry* cupping have been used; these scarcely need explanation, more than has been given. In *wet* cupping the scarificator is used, by which several incisions are simultaneously made through the integument; and then the cup of glass, having been exhausted of air, is applied to the part; whereupon the blood is forced by atmospheric pressure into it, from the numerous small vessels that have been divided. Dry

cupping consists in using the cups alone, by which the blood is drawn to the skin and subcutaneous tissue, there to be retained for a time.

Direct evacuation of blood from a part may be performed by three methods,—by cupping, or by leeching, or by punctures. Cups or leeches must never be applied directly to the inflamed tissue, as it would be an additional source of irritation; and the bite of the leech is particularly so, because of its poisonous nature; the result of which would be that, although the congested part might momentarily be relieved, yet the blood would thereafter be more freely drawn to the part. The blood, therefore, must be abstracted from tissue in the immediate neighborhood of that inflamed. The current of blood pouring to the part will then be turned aside, and a diversion created which will have the effect of relieving the vessels which had wellnigh become paralyzed.

The practising surgeon ought to be well acquainted with the details of practice. In cupping he should see that no unnecessary pain is inflicted,—and careless cupping may cause a good deal that ought to be avoided,—that the clothes are not soiled by blood, and at the same time that it is done in the most expeditious manner. In country practice it will often happen that this operation requires to be performed when the cupping glasses and scarificator are not at hand. But, with regard to the glasses, a ready and serviceable substitute will be found in the wineglass or tumbler; then a few drops of alcohol dropped into it and ignited by a little slip of paper, will exhaust the air. And in the absence of the scarificator, should the patient stand in urgent need of wet cupping, the part, after having had the cup applied to it, may be punctured quickly in a few places, as a substitute for scarifying. Cupping cannot be too highly recommended, especially in cases where an internal organ is congested or inflamed.

Leeches.—In cases where the surface is so uneven that a cup cannot be used, leeches will, if obtainable, take its place. Again, sometimes the part is so painful or sensitive that cupping cannot be tolerated by the patient; in which case also leeches must be substituted. There are also many parts of the body to which cups could not be applied where leeches will be found to answer instead. The fact that the leech-bite is somewhat poisonous is to be remembered. Sometimes, if applied to the affected part, it increases the

inflammation very much; and often, when applied to tissue that is lax, as about the eyelid, it will give rise to a good deal of serous infiltration.

Puncturing.—Incisions made in the tissue inflamed will often give very great and prompt relief to the patient, prevent extension of the disease, and perhaps destruction of the tissue. These cuts should be short and quickly made. The patient will be likely to object to this practice because of the pain; and, if the part is commonly exposed, for fear of a scar resulting. When the incision is first made, as the tissue is more or less distended, swollen, there will be gaping, perhaps, to a considerable extent; but generally, after the swelling subsides, in consequence of the escape of blood, the cuts do not appear so large; while, should no incision be made until pus form, the risk of a resulting scar will be far greater. The bleeding can be promoted by fomenting the part; at the same time the part is thereby soothed.

There are other methods by which blood may be drawn from a part, or rather turned into another place, as by *counter-irritants.*

In not a few cases of inflammation a mustard poultice will give to the patient, seriously ill, with symptoms of no little disease, the most prompt and efficient relief. This I have seen more especially follow its use when an internal organ was involved. It is not a little strange that a remedy so efficacious should, even among intelligent practitioners, be so rarely used. I have seen it used in many hundred cases as a counter-irritant, and always with benefit, never with harmful effects. The *modus operandi* is very simple. The mustard acts as an irritant to the skin, and engages the nerves, by which a diversion is created. I cannot find a more convenient and expressive term. The irritation is followed by a flow of blood to the part where the mustard has been applied. Mustard and other like substances are particularly useful in the first stage of the inflammatory process; but they are also beneficial at almost every subsequent period. The length of time necessary to produce the required irritation and congestion will depend upon the age, the sex, the sensitiveness of the part, as well as the strength of the mustard. From ten to thirty or forty minutes will, as a general thing, be sufficiently long. The directions I am in the habit of giving are to apply it immediately to the skin, and leave it there until the part is well reddened.

Mustard is a *rubefacient;* and when it cannot be had, although that is not often the case, other means may be adopted to make the skin red. Brisk rubbing will do it; and I have seen prominent symptoms of congestion of the lungs dissipated by this process. Fomentations of very warm water, reaction after cold applications, or a hot linseed poultice, will redden the skin, perhaps at the same time affording relief by soothing the nerves and relaxing the tissue.

Pressure made against the part, so as to force away the fluid, and prevent its entrance, and thereby to sustain the distended vessels, is another excellent remedial measure. The importance of such pressure has been explained in connection with *astringents.* Pressure is, indeed, another similar mode of using mechanical force. It is commonly effected by a bandage. But, as the pressure requires to be uniform, it is obvious that the bandage should be accurately adjusted; otherwise it will not only fail to do good, but will be the source of very great evil. In case the bandage is not made to fit perfectly the varying form of the limb, the pressure will be greater in some places than in others, and the parts not duly pressed upon will become the seat of inflammation, at least of swelling. Should, for instance, a bandage be applied more tightly at the ankle than around the foot, the return of venous blood will be arrested in the superficial veins, so that it will naturally collect in the foot, and aggravate or even cause inflammatory action. As the art of bandaging can only be acquired by considerable practice, I would recommend students to gain some knowledge of it by practising on one another. I will risk being thought too lengthy on this subject, that there may be no failure to bring before the reader the important bearings of this remedial measure. This is done because many instances have come under my notice where the obvious, and, one would think, simple principles of this treatment were grossly violated (and that by surgeons of experience and deserved reputation), and to such an extent as to jeopardize a limb. I have, in not a few cases, when called upon to give advice, in consultation upon inflammatory affections of some one of the several limbs of the body, proposed the use of judicious bandaging, which proposition met with the declaration that a bandage had been tried, but could not be tolerated; but, on making inquiries, have ascertained that the bandage had not been properly

adjusted. That such had been the case was substantiated by the fact, that subsequent bandaging was attended with the greatest benefit. Many surgeons, having seen the evils of uneven, imperfect bandaging, cease to use it altogether. To this subject reference will be made in connection with the treatment of fractures. It will suffice here to add, that the bandage should always be made a degree tighter at the extremity of the limb, where it should always be commenced; and, as the hand carries the bandage up the limb, the roller will be less firmly applied.

But pressure may be effected by other means than bandaging. Astringents are useful as such: the tincture of iron I have found particularly so in those cases where the congestion is somewhat asthenic; but not sufficiently so to demand the use of iodine. Now there are parts of the body to which a bandage to make pressure cannot be used; as an inflamed breast. In such cases I can recommend, as an efficient agent, the collodion. By means of it uniform and active pressure may be exerted upon as much of the part as is requisite. For a knowledge of the value of this agent in the treatment of acute inflammation of the mamma, I am indebted to Dr. Cook, of Canada West. Upon this subject Dr. Cook furnished an interesting and instructive paper, to be read before the Medico-Physical Society of Victoria College,—a society which, I would say, "IN MEMORIAM," that, although short-lived, conferred a lasting benefit upon every member who attended its meetings. In his paper were detailed several cases in which inflammation of the mammæ had by him been successfully treated by collodion. Dr. Cook would not undertake to explain its *modus operandi*. After reading the luminous lectures of Hilton upon the subject of "rest," the necessity of such, I found no difficulty in attributing the usefulness of collodion in part to the pressure which it makes upon the tissue after the ether has evaporated; and, in part, to the *rest* which is thus secured to the part, the coat of collodion effectually preventing any motion in the inflamed structure.

Thus far, in considering the treatment of inflammation, I have spoken more especially of local treatment; although much has been said relating to constitutional remedies; particularly in speaking of evacuants, we have seen that *purgatives*, *diaphoretics*, and *diuretics*, by opening the pores of the mucous membrane of the

intestinal canal, the skin, and by causing secretion in the kidneys, give relief to the inflamed part, reduce the heat of the body, and thereby obtain relief for the constitution generally.

CHAPTER X.

Constitutional Treatment—Special Medicines—Antimony—Mercury—Opiates —Veratrum Viride—Aconite—Nitrate of Silver—Potash.

In treating the constitution specially, our attention may have to be, in the first place, given to some peculiar constitutional fault, which had been a predisposing cause of the disease. It may be necessary to take steps to effect the removal of this evil at once, at least to place it in subjection, until the local disease is conquered. Subsequently, or perhaps at first, the treatment will be directed to the effects of the local disease upon the constitution—that is, the *inflammatory fever*, with all its concomitants. In many cases, however, the course pursued by the surgeon will have to be reversed: the inflammatory fever will need to be subdued, and thereafter any previously existing evil attended to.

It would be beyond the province of this work to even refer to the treatment of the various evils which constitute the predisposing causes of inflammation. Some of them, however, will be considered in connection with special forms of inflammation.

Of the treatment of inflammatory fever we have already learned so much that, in giving it a special consideration, not a great deal has to be said. I may here repeat that at first an active purgative should be administered, to start into action the sluggish or dormant intestinal canal; after which, diaphoretics and diuretics, alone or combined with sedatives, will be given. And in the mean time, mental and physical *rest* should be observed.

Individually Important Drugs.—So far, classes of remedies have mainly been referred to; but there are certain individual medicines, in some respects specifics, which, because of their frequent use and deserved standing, demand especial notice. The first of these, which I now proceed to notice, is

Antimony.—It is a medicine of great value, and as such has been regarded for many years. As an antiphlogistic it is administered to produce, in the first place, sedation. When given in certain doses it causes nausea, the effects of which are reduction of the heart's action, and a sensible relief to the whole vascular system, the tone of which had been so much increased. Vomiting as a general thing, it will be remembered, is to be avoided; the object is to produce that extreme nausea which precedes vomiting. To do this, and avoid the vomiting, the drug must be given in small and frequently repeated doses. The quantity will have to be very gradually increased, as the system acquires a tolerance, else the effect will not be maintained. Antimony not only acts as a sedative but also as a diaphoretic, a diuretic, and, in some instances, upon the bowels, causing purgation.

Mercury is the next medicine deserving of special notice. It is a drug not so generally in use at the present time as it was formerly. It has been very extensively used, and very much abused. Like a great many other really useful medicines it became a "cure-all," and was ruthlessly given when not required, and exhibited in larger doses than was necessary. Unfortunately it is not a harmless medicine; and its injudicious, its empiric use, has probably done more harm than is counterbalanced by the good it has ever effected. It is, therefore, a cause of thankfulness that its popularity has so much decreased. The conviction that it led so often to evil effects, caused the Surgeon-General of the United States Army to issue an order, that thereafter no medical officer should employ it.

There are two views now held, I believe, as to the manner in which mercury acts upon the system as a remedy for inflammation, one of which is, that it stimulates the absorbents into a more healthy action. "Stimulating the absorbents" is a common and a convenient expression; but what does it signify? The absorbents cannot reach for material to take up,—cannot draw to themselves a fluid which is not in contact with them. The material must be brought in immediate contact with the coats of the absorbent vessels by some other process. (Williams.) Again, if fluid be in contact with them, and if the disease do not incapacitate them, they will readily discharge their duty. But while there is inflammatory action, we have seen that transudation through the

coats of vessels is, to a great extent, arrested; there is too much tone. Now, if mercury acts as a stimulant, this tone would be further increased. The inference is, that if mercury stimulates the absorbents, its use is contra-indicated, so long as there is active inflammation, at least; and it remains to be shown that the absorbent vessels require any stimulation after inflammation has subsided,—that is, in acute, healthy inflammation. When the disease is more chronic, and a want of tone is manifested in the absorbents, then a stimulant is undoubtedly indicated. I would not, then, recommend mercury as a stimulant to the absorbents, because those vessels are too much irritated already. And in the treatment of effusion, due to a more chronic action, I think other remedies can be found to do equally well, and which are incapable of producing that mischief which mercury may lead to.

But I venture to state my belief that mercury never does act as a stimulant to the absorbents. In those cases where its administration is followed by increased absorption, is it not due to the effects which the drug has had upon the fibrin of the blood, or the inflammatory lymph. And this is the *second view* of the two, above stated.

It is conceded, by all observers, that mercury will retain the fibrin in solution—that it prevents coagulation; and often, after coagulation has taken place, it will liquefy it again. Now, when it is remembered that such a state of fluidity is conducive to speedy recovery after the inflammation has subsided, it will be admitted that mercury, to act thus upon the fibrin, is a valuable medicine. But it must not be forgotten that it may injuriously affect the constitution, and that for life. Such being the case, it is well to inquire if some substitute cannot be provided,—a substitute which, while it will accomplish as much, *i. e.*, will have the same effect upon the fibrin, cannot, under any circumstances, lead to the same disastrous results constitutionally. It is now well known that certain salts, as the preparations of potash, will keep the fibrin in a liquid state quite as well as mercury. I will only add that I have tested the virtue of potassa, and can recommend it.

Opiates.—Opium and *similar medicines* are most valuable remedies in the treatment of inflammation. They may be applied directly to the affected part, either alone or in conjunction with some other medicine, as an astringent; or they may be adminis-

tered internally. Opium is particularly useful in inflammation of the abdominal region, as before remarked. This can readily be understood. It is the function of the intestinal canal to so move, as to pass the contents along; there is almost incessant vermicular action; and in its various convolutions it comes in contact with every part of the abdominal parietes and the several viscera. The intestines are suspended in and confined by a membrane peculiarly susceptible and sympathetic. In all cases of inflammation, *rest* is the first and important desideratum, in order to establish a sure hope of cure. Now, opium, when given, acts directly upon the intestinal canal and the glands, and soothes the muscular fibres to rest; it arrests those secretions which will stimulate the intestines to action. The use of opium is rarely contra-indicated, unless there be severe head symptoms; and, in all forms of inflammation, it will be found to have a happy effect upon the constitution generally. The dose will, of course, vary according to the intensity of the pain and the age of the patient. In abdominal inflammation a full dose should be given. Where there is apprehension that the system will not bear it, because of some idiosyncrasy, small doses, often repeated, must be the practice.

Veratrum Viride is a medicine which does not enjoy the long-established reputation which belongs to antimony, but it successfully rivals that drug as a powerful antiphlogistic. It is a potent agent; yet in the hands of the cautious surgeon it can be safely exhibited, and, according to my own experience, with the most satisfactory result. Its action upon the heart is promptly and powerfully sedative. It also acts as a diaphoretic, causing, in a very short time, the skin to become cool and moist. I have found it particularly useful in inflammation of the lungs. Two cases of such, which were also most interesting in a surgical point of view, I will particularly refer to. These were cases under my immediate care in Lincoln Hospital at Washington. Both came in at the same time direct from the battle-field. The first one which engaged my attention was unable to lie down, but had to sit leaning forward considerably. His efforts to breathe were most urgent. He could barely tell me that he was wounded in the chest—that the ball had passed through his body. I hastily looked at the wound in front, which was the place of entrance; it was between the fifth and sixth ribs, on the right side of, and very near to the

sternum. I not only considered his case hopeless, but thought he could not live an hour. I ordered him a draught of compound spirits of ether, which was shortly repeated. In half an hour he went to sleep, his head resting forward on a chair, made somewhat comfortable for the head. He slept for two hours or more. During the sleep and on waking he could breathe a little more easily. I examined the wound posteriorly, and found that the ball had passed almost directly backwards and had made its escape. It was now some thirty hours since the reception of the wound. The action of the heart was labored and there was some fever; the skin was hot and dry. I put him on veratrum viride; to be given often, in small, drop doses. I had every reason to believe, from the symptoms, which I cannot here fully describe, that the ball had passed through the lung. It was several days before the patient could lie down. Symptoms of pneumonia presented themselves, but were kept under control, and finally the patient became convalescent.

The other patient was also wounded with a ball, which had struck the right clavicle at about its middle, and, shattering the bone, had buried itself in the part. In this case, also, there was well-marked signs of the lung being wounded. At first the distress was not great, the dyspnœa but little; in two days, however, it was very great. He was ordered the veratrum viride every three hours. I found it unnecessary to give anything else. In a few days the symptoms of inflammation subsided. Because of the important structures immediately beneath the clavicle, the ball was but slightly searched for. When the patient passed from under my care his condition was most promising. The wound remained open, from which was a little purulent discharge, which might have been due to the necrosed state of a part of the clavicle. Now, both of these men were young and full of healthy blood, but neither general nor local bleeding was deemed necessary. The inflammation was successfully treated *solely* by the veratrum viride.

Aconite is an antiphlogistic, highly recommended; but, as I have not had occasion to use it, I cannot speak from personal experience.

Nitrate of silver is the only other medicine to which I shall especially direct attention. There are others, certainly, of no mean

value; but many or most have been referred to in connection with the several classes of remedies, and of these I would particularly specify sugar of lead and nitrate of potash.

Nitrate of silver is used as a local remedy, and as such is often valuable, especially in limited inflammation of the skin or mucous membrane. It must be used in solution, and of not too great a strength. When thus applied it seems to amalgamate with the superficial part of the skin, by which a coating is formed; thus it seems to dry up the tissue with which it comes in contact. The covering thus formed seems to protect the irritated nerves from the air and other irritating agents. Not unlikely the periphery, which was principally engaged, is actually destroyed by the caustic effects of the silver. Even when the inflammation is subcutaneous, the solution, often by acting upon the nerves through reflex action, gives a degree of relief; that is to say, by soothing the cutaneous nerves, other nerves in the same district are sympathetically soothed.

In cases where some animal poison, as that of gonorrhœa, has been deposited upon a part, and is there acting as a cause of, and is gradually begetting inflammatory action, the process of incubation may be arrested by the application of the silver, which will destroy, dry up the outside tissue, and at the same time destroy the poison. To secure this happy effect the application must be made before the inflammatory action is established. Subsequently, when the active symptoms have subsided or disappeared, and there remains a chronic discharge, a gleet, the solution may again be called in requisition. Here again the beneficial effect is attributable to the protection given by the coating to the nerves in a morbid condition. The function of the membrane has been changed by the gonorrhœa, and, although the cause of the inflammation may long since have passed away in the discharge, the membrane remains in a morbid state in consequence of the periodical discharge of the urine from the bladder, and so the discharge continues. But the silver, in the way described, forms a covering to the surface, and the urine thereafter ceases to irritate it, physiological rest is obtained, and recovery soon follows.

I will conclude this branch of the subject by repeating, that the treatment of the inflammatory process will always be modified by the circumstances of the case. The surgeon will not lose sight of

the various surroundings of his patient; the causes, local and general, which may continue to operate. He will not fail to consider his age, position, and particularly the nursing which he will receive; for, the more intelligent the nurse, the less will the surgeon have to do. He ought to forewarn the nurse of any probable or possible evil which may at any time arise to complicate the case, and render a more vigorous treatment necessary.

CHAPTER XI.

Treatment of the Products of Inflammation—Of Serum—Liquor Sanguinis—False Hypertrophy—Induration—Atrophy—Degenerated Lymph—Pus—Abscess—Pointing of Abscess—Diffused Pus—Mucus—Blood.

Thus far I have considered the treatment of the inflammatory action, have described the classes of remedies suitable to each stage of the process, and dwelt upon some of the more important medical agents with which the practising surgeon will deal. I now come to speak of such treatment as seems most suitable to each product of the disease. The products of inflammation are, it will be remembered, serum; liquor sanguinis, composed of serum and of lymph; blood; altered mucus.

Treatment of Serum.—As a general thing, this product of inflammation will be easily removed by nature if the inflammation have ceased. Familiar instances are known where it has been accomplished after pleuritis; even large quantities have been rapidly and completely absorbed after the disease has been arrested. So that in healthy inflammation, where serum is the only product, the surgeon need give no special attention to it.

Liquor Sanguinis is also often effectually removed by the unaided powers of nature. As long as it remains fluid this may be accomplished; and we have learned, that in inflammation, the increased vitality of the fibrin serves to retain the compound for an increased time in a state of fluidity.

The separation of the serum and the lymph is followed generally by the absorption of the former, and an attempt to organize on the part of the latter.

Speaking, generally, the lymph may coagulate or degenerate into pus. In either case removal by absorption becomes slow, or even impossible, unless art be employed to assist nature. The surgeon, then, will endeavor to promote absorption, and aim to retain the lymph in solution; or, if it have solidified, to bring it back into the same state, so that absorption may be possible.

We have seen that mercury enjoys the reputation of being a stimulant to the absorbents (this, however, is questionable), and of being competent to prevent coagulation. Further, it is able to produce liquefaction after solidification has taken place. Mercury, for these purposes, has been and continues to be frequently used. But we have also learned that the use of mercury may be attended with or followed by very great constitutional evils; therefore, if any other medicine will accomplish as much, or nearly as much, it by all means ought to be employed instead. I repeat these statements here because of their great importance, as well as to bring out the importance of the fact that the lymph often remains fluid for some time, and that a medicine so heroic and dangerous as mercury ought not, as a general rule, to be administered to prevent coagulation from taking place. At least before employing it, be convinced that it, or some such agent, is demanded. Never give it blindly; never run in the grooves of routine. I am not prepared to say that, in case of pericarditis, or of pleuritis, or of peritonitis, when it is feared that adhesions will form between surfaces which come together, and by which the organ may irretrievably suffer, perhaps by which death will be produced (for, in such cases, of two evils I would choose the least); but I do say that it is only in such urgent and life-important cases that mercury ought to be given to salivation. More than this, I expect to see the day when even in such cases a safer remedy will be invariably employed. And in considering this question, we must not forget that, even after coagulation has taken place, nature, in many instances, alone will do very much.

The inflammation ceased, and the part at rest, even solidified fibrin is often removed. Of course when the heart and pericardium have united together, or the pleura costalis is adherent to the pleura pulmonalis, or one fold of the peritoneum to another, the constant motion of the parts almost precludes the possibility of that repose without which repair cannot be effected. But even in

these cases nature at least tries to ameliorate the evil; and after a time, perhaps very lengthy, the bonds of union are very much lessened, although not removed. For instance, in granular lids of the eye, where lymph exists to a considerable extent in an organized form, if the eye be kept at rest for some time—perhaps a long time may be required—nature will remove the adventitious material, while the union which had taken place between the mucous membrane of the lid and that of the eyeball will be considerably reduced. Under such circumstances we often speak of stimulating the absorbents. Elsewhere it has been shown that stimulation of the absorbents, in the true sense of the term, is inappropriate, inasmuch as stimulation of the vessels would only add to the difficulty. What is necessary, and what the surgeon can only wish to secure, is the liquefaction of the material, and then the contact of it with the absorbent vessels; and anything which may be given or applied must be in accordance with these indications. To this end mercury may be administered, and so may the iodide of potassium. Of the latter medicine I think I cannot speak too highly. For the same purpose iodine alone is sometimes given and applied to the part. However, it should not be done, so long as the part is inflamed. I have seen a large number of cases in which the tincture has been applied externally with the effect of rekindling the inflammation. It is a question whether it will, when applied to a part, have any direct effect upon the absorbents. I am disposed to believe that the iodine, when thus used on the skin, unites with the cuticle and forms a firmer covering, by which a degree of rest is secured, and at the same time a certain amount of pressure is made, whereby the material to be removed is brought in contact with the coats of the absorbents. There is at the same time, undoubtedly, a degree of stimulation; and hence the important fact that it should never be used until excitement has quite subsided; and the other fact, that iodine is more useful when there is a tendency to, or actual state of, asthenic action.

Counter-irritation is of great value, as, for instance, in granular lids and vascular cornea, a blister frequently repeated behind the ear, or in front of it, or perhaps a small seton. Also, where adhesions have formed between the pericardium and heart, a seton over that organ will often divert nature, and thus obtain a

degree of required repose. A recent and more acute irritation engages nature in one respect, while in another respect she is relieved of a degree of excitement inimical to repair.

Suppuration will prove serviceable in some cases. If the lymph which has become organized, and is productive of evil, can be made to degenerate into pus, a step is thereby made toward a return to fluidity. (*Vide* Treatment of Pus.)

Treatment of False Hypertrophy and Induration, and Atrophy arising from a deposit of inflammatory lymph.—When false hypertrophy results from inflammation, that is, when the lymph which has been thrown out becomes incorporated with the tissue by organization, the question arises whether the surgeon can do anything to cause or hasten its removal. It will be necessary here to say a few words which will forestall remarks which I shall have to make in connection with the healing process.

It is a law well recognized, that in the body, as in nature generally, like begets like; that every tissue in the human fabric constantly, as parts wear out and die, beget other like structures: this we have learned. *Now when inflammatory lymph is effused, and becomes organized, it possesses no such vital powers.* The adventitious matter, it is true, possesses a certain degree of vitality, so that it lives for a time, occasionally for a long time; but when it does die, no other like material is begotten to take its place, unless it be derived from the blood, and is a *product of continued inflammation.* Thus we find that fibrin, as a product of inflammation, if it coagulates and does not subsequently reliquefy, remains in the part until it lives its period of life, when, being removed by the absorbents, in accordance with physiological laws, there gradually take its place the natural tissues of the part.

In these cases, it will be seen that time is required to restore the part; and, I will repeat, that quietude is of supreme importance. We understand now the doings of nature when lymph has become organized; it matters not whether it be a case in which there is *no perceptible change of form*, or it be *hypertrophy*, or *induration*, or a *certain form of atrophy.* Bearing in mind these doings of nature, it is the surgeon's only duty to try to assist her; and what has been recommended heretofore, will in all cases be trusted to as the surest way in which to render service.

Treatment of Degenerated Inflammatory Lymph.—Inflammatory lymph may undergo several forms of metamorphosis, commonly called degeneration. Perhaps, with but few exceptions, all forms of metamorphosis which are not of development, are, at the same time, degenerative changes; that is to say, when a tissue or an individual cell becomes changed, it assumes a lower place in the scale of animal life, and at the same time has taken a first step towards ultimate death.

We have seen that inflammatory lymph, which is itself an abnormal material resulting from inflammatory action, and which possesses a certain degree of vitality, may, to a limited extent, become developed, and for a time form a part of the body. On the contrary, under certain circumstances, it is found to degenerate into one of several forms. Paget speaks of the following, viz.: Into a, 1st, *horny substance;* 2d, fatty degeneration; 3d, *calcareous degeneration;* 4th, "pigmental degeneration of fibrinous lymph, in the various shades of gray and black, which often pervades the lymph formed in peritonitis."

Treatment of Pus.—Degeneration of lymph into pus is by far the most frequent; indeed, it is the only one to which we, as surgeons, need particularly direct our attention. It is in reality a fatty degeneration. Oil globules cannot always, it is true, be seen in the pus-cells, especially when recent; but they will soon begin to show themselves. It is difficult to draw the line of demarcation between the cell of inflammatory lymph and the cell of pus, although there is no doubt that the former is gradually converted into the latter. It may with safety be said, however, that when oil globules are detected in the cell, it is no longer a lymph-cell, but a pus-cell.

It is desirable to re-state here the important fact, that these degenerative changes in the lymph are seemingly so many steps taken by nature to get rid of the material which has resulted from the inflammatory action. And this brings me to the statement that pus may be absorbed. It is an old doctrine, and one which may not easily be cast aside, that pus cannot be absorbed. Certainly, pus-cells are too large to be taken up by the absorbents; but we have ascertained that pus-cells, as they grow old, gradually enlarge, while the oil globules form within. At last the wall,

having become thin, breaks down; and thus it is that pus is gradually prepared to be taken away by the absorbents.

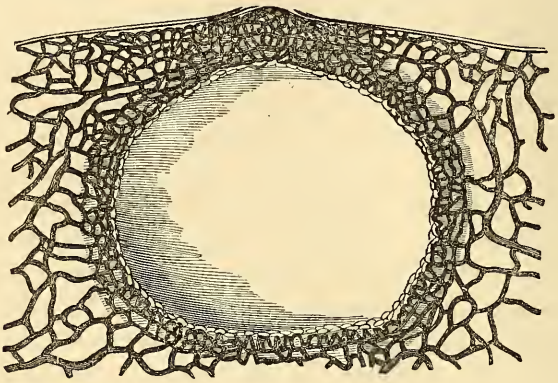
Pus, it has been stated, may form in three ways: 1st, in the form of an abscess, circumscribed; 2d, diffused in the cellular tissue; 3d, upon the surface of a membrane.

Now we will suppose that a certain tissue has been inflamed. The disease has subsided, or, perhaps, even while it continues, there exists, as a product of the inflammation, a quantity of coagulated lymph. The cellular tissue has been pressed together and aside, and within the tissue is this adventitious material. Too great in quantity to be supplied with bloodvessels, it is doomed to die; not, however, at once, but by that gradual process of degeneration which has been described above,—a fatty degeneration, resulting in actual death of the component cells. In this case we have supposed that the lymph became at first a coagulated mass, and afterward degenerated into pus. Such is very likely to be the course when an abscess forms, but it is not always the case; instead, the lymph may, after being effused, pass into the form of pus, not having previously coagulated.

Taking the mass of solidified fibrin, it is found that, as a general thing, the degeneration commences at the centre of the mass. This is the oldest portion of the clot and the farthest removed from the sources of vitality, and may be expected to first yield to the degenerating process. The softening gradually extends from the centre towards the circumference, until the whole mass is softened. But the surrounding tissue, in which is infiltrated the lymph, and which is more or less condensed by pressure, will form a very perfect barrier, by which the pus is completely inclosed, and by which the outside tissue is in many cases protected from the encroaching pus. When an abscess, then, is fully formed, there is in the centre the fluid; around this a hardened barrier of lymph and tissue; and, without the barrier, the tissue, in most cases, is very much congested. (See diagram, p. 96.)

The Process of Pointing.—The process of degeneration, characterized by increase in size of the lymph-cells, and a general increase of the contents, causes pressure from within. This pressure is equal in every direction; consequently, upon that side where there is the least resistance, the pus will gradually make its way. Hence it is that pus, as a general thing, finds its way to

the surface of the body. But if a resisting membrane, or a fascia intervene between the collecting pus and the surface, then it will burrow in some other direction, where there is less to obstruct its



way. Again, sometimes, when the abscess is located in an internal organ, as the liver, the matter, instead of approaching the surface of the body, takes a more easy course into the intestinal track, or perhaps a more lengthy route; yet, nevertheless, a more easy one. While writing this, I have under my care a man with unmistakable symptoms of abscess of the liver, the pus of which found an outlet by way of the left lung, through the bronchial tubes. There is one general law always manifested, namely, the pus does not take the nearest way, but the *easiest*, to obtain its escape. There might, seemingly, be an exception to this law, as exhibited in the fact that abscesses, although near to, rarely open into a serous sac, notwithstanding the resistance cannot be said to be very great. But in these cases a wise and preservative law of nature shows itself—one before referred to—namely, that, in connection with inflammation of serous structures, the tendency is to adhesion. Inflammatory action must precede the formation of pus. Now, if that action begets a layer of highly organizable lymph, as it will, upon a serous membrane, the part is thereby strengthened, and a barrier is formed which will generally resist any advances in that direction. There are some tissues which possess the ability to resist the pressure made by pus, so that it may actually bathe them; for instance, the coats of bloodvessels are rarely affected

by abscess. They are, as a general thing, pressed aside by the lymph; but they have been known to traverse an abscess and yet remain unaffected. If, however, the coats be examined, they will be found thickened, as if a coating of lymph had been formed around. And so it may be, after all, that the vessel owes its preservation, not to the powers of resistance in the tissue, so much as its ability to supply in this contingency lymph of high vitality.

The pointing of an abscess can, from the foregoing, be readily understood. Pressure upon any tissue, if continued for a sufficient length of time, will cause its destruction. The pressure produces an early death of the ultimate particles of the tissue, which seems to be attended with a degree of softening, and the *debris* is carried away by the absorbents, while there is not that ordinary repair which takes place in a state of health. The result is that the tissue is gradually eaten away until finally the pus breaks through and escapes—the pointing process is completed. Thereupon the pus within is discharged until the pressure is relieved. The tissues which had been thrust aside will gradually resume their proper position, and, if the opening be sufficiently large, the contents of the abscess will entirely flow away.

While the pus is thus escaping from the abscess, the walls, composed of lymph and cellular tissue, will be found to undergo certain changes. The lymph will, to a great extent, degenerate into pus; the cellular tissue will either die and mingle with the pus in the form of *debris*, or recover its vitality; this will depend upon the degree of pressure to which it had been subjected. Around where the barrier was, physiological action will take the place of pathological. And upon the inner surface of the walls will, in due time, be found granulations and extraordinary repair taking place, to close up the cavity resulting from the discharged abscess. (*Vide*, the Healing Process.)

These, then, are the steps, either one of which may be taken by nature to get rid of pus, when it results from inflammatory action, namely, liquefaction, degeneration, until the cell-wall breaks down, thereby allowing it to be absorbed; or, if this be impossible, from the quantity of pus, or from the continuation of the exciting cause, then steps are promptly taken to dispose of it in a more summary manner by the process of pointing.

Such are the workings of nature, and hereby must the surgeon

be guided in any step he may propose to himself to take in rendering assistance. In two general ways he may assist. Possibly he may remove, or limit the cause of the formation of pus—may cut off the source of supply, break a link in the chain of morbific causes, whereby the part will be placed in a condition favorable to restoration; or, if this be impossible, if the matter will continue to collect, and will find its way by pointing to the surface to escape, then there is a second way in which the surgeon may assist. It is possible to abridge the process of pointing, and instead of allowing those hours and days of painful work, which attend nature's doings, to make an opening for the pus to escape, the surgeon should divide the tissues by the knife.

Poulticing and hot applications may, by softening the tissue, and soothing the irritated nerves, do some good; but, when pus is known to exist, there should be no hesitancy in promptly making an opening for the pus to escape. More than this, it is better to err on the safe side, by making too early an incision—that is, before the pus really exists—as the incision can do no harm, while it may so relieve the part of congestion that suppuration will be averted.

The instrument with which the opening should be made will depend upon the position of the abscess, and its depth. If the wall be thin, the most convenient instrument is the abscess, or the ordinary lancet; when it is deeper seated, a stout bistoury will be required to cut through the intervening tissue; and when the abscess is somewhat elevated above the surrounding surface, as in a bubo, the most convenient instrument is the curved bistoury. This must be made to transfix the elevated walls to a sufficient extent, and then to cut its way upwards so as to divide the intervening tissue. When the abscess is deep-seated, there is danger that the wound made may close again, after some of the matter has escaped; to prevent this, a piece of lint must be introduced, and allowed to remain at least till the following day. (Hilton's Method of Opening; Lancet, 1860, vol. xi, p. 454.)

I wish here particularly to point out the evil of a practice, a long time in vogue, and yet practised by many high in authority. I refer to the custom of squeezing out the pus after the abscess has been opened. It is not only unnecessary, but as it is actually painful, therefore it is objectionable. Nothing can be advanced

to support the practice, unless it be that it is gratifying to the surgeon to see the amount of matter for which he has provided a way of escape. The surgeon's only duty is to secure a free opening, and then treat with the view to arrest the formation of any more pus: an end which will not be reached by pressing out the pus and putting the patient to pain. There is always quite enough of irritation and pain attending the operation, without unnecessarily increasing it. To allay this irritation, warm applications may be used, first in the form of warm water, and afterwards by a poultice of linseed meal; and this latter will also secure a gradual but free evacuation of the abscess. Following closely upon the heel of this will be the first steps of the "healing process;" not, indeed, but that everything thus far has been a process of healing. All that the surgeon can have done was to give assistance to a natural process. But very soon healing in a more perceptible manner commences. The poultice which had been applied should be discontinued, not to be again used, unless, from some cause, the pus should begin to collect; under such circumstances, a poultice may to advantage be at least applied at night and removed in the morning.

We are now on the boundaries of another subject,—that of the healing process, which has to receive a separate consideration. Suffice it to say here, that nothing can be done by the surgeon to make a part heal; it is a natural process, and all that can be done is to keep the part in such a position as will allow nature to work without embarrassment. To accomplish this, all that is necessary is to retain the part at rest and protect it by water-dressing.

The *second form* in which pus is met, is where it is diffused. There is no large collection; no barrier of lymph and condensed tissue. The lymph which has degenerated into pus occupies the tissue in small quantities; it is distributed in the cellular spaces. Degeneration takes place simultaneously in several of these. Sometimes, as it collects, several of them will coalesce. But there is an absence of centralization: unlike an abscess, in every respect. A single opening will not secure a discharge of the pus, for it occupies, not one, but many chambers. In this form of disease there is always some potent constitutional cause; so much so, that it may be looked upon as a variety of inflammation. The

treatment is the same as that pursued in certain forms of erysipelas. (*Vide* that disease.)

Pus, which forms *upon a mucous membrane*, may in many respects be regarded as mucus in an altered state. The blood which normally circulates in the part, and from which the mucus is secreted, coming thereto with unusual rapidity, gives rise to the phenomena of inflammation. Transudation, at first arrested, soon takes place in increased quantity; but now, instead of mucus, it possesses rather the characteristics of pus. Or it may be, that while some of the fluid forming upon the surface is decidedly purulent, other portions retain the nature of mucus.

The treatment to be observed is obvious. There is too much blood going to the part; this is due to some irritation. The first consideration is to effect the removal of the irritating cause, whatever it may be: whether a poison, as in gonorrhœal conjunctivitis; or continued motion, which so frequently keeps up inflammation of the eyes; the cause must be removed. Then, the blood circulating normally, the pus will gradually cease to form, and the function be restored. If the inflammation have continued for a long time, the membrane may have become so changed, that, although the cause is removed, the pathological state will remain for an uncertain period of time.

Mucus as a product of inflammation requires no separate attention. Every principle as to pathology and treatment has already been considered under "Pus upon the surface of a mucous membrane."

Blood is the only remaining *product* of inflammation. Inasmuch as it demands no special attention in the way of treatment, it need not here be discussed.

CHAPTER XII.

Diseases arising out of Inflammation — Passive: 1. Congestion; Results — Treatment, Local and General. 2. Chronic Inflammation; Products — Treatment.

THERE are certain conditions frequently seen in connection with, or arising out of, the inflammatory process, which have generally been considered in connection with it, and which are called remote products of inflammation. These conditions possess distinctive features, in which can be seen the morbid, preponderating. There is more of the pathological than of the physiological. The inflammatory process, such as we have endeavored to trace, and whose footsteps we have closely followed, has been, in the main, on physiological grounds. And all along the way, we have seen evinced the most judicious and successful arrangements of nature to effect a cure. But we now must turn into another path, in which nature's efforts seem to a great extent abortive, in which disease essentially obtains—where the pathological supersedes the physiological.

This plan, although novel, will, I think, simplify the matter for the student—an object I have steadily in view; for I hold that in the medical profession there is more to learn than can well be acquired, and that the road ought to be made smoother and smoother by each traveller as he passes along.

The *diseases arising out of inflammation* are: 1. Passive Congestion. 2. Chronic Inflammation. 3. Chronic Abscess. 4. Pyemia. 5. Softening. 6. Ulceration. 7. Sloughing. 8. Gangrene. 9. Induration. 10. Hypertrophy. 11. Atrophy.

It is impossible to draw a distinct line of demarcation between healthy inflammation and unhealthy—between healthy products and those which are otherwise. Hence it was, that induration, hypertrophy, and atrophy received attention in connection with healthy inflammation, however at times they do present more the characteristics of disease than of healthy action.

Passive Congestion.—In this disease, there is too much blood in

the part affected; not because there is too large a quantity sent, but because it cannot flow therefrom in a normal manner. Here is a condition widely different from that which has been described as *active congestion.* The vessels which are engaged belong rather to the venous system; the blood within them is venous.

Causes.—Two general causes may be specified: 1st, obstruction to venous return; 2d, a toneless condition of the vessels and parts generally. The obstruction may exist immediately at the part, or it may be more remote. Taking the foot for example, if it be the seat of passive congestion, the cause thereof may be found close by, at the ankle, or at the knee, or even at the pelvis. Many causes of mechanical obstruction may be enumerated—such as external pressure, in the form of a garter around the leg; or a tumor may press upon the vein so as to retard the flow. The gravid uterus may press upon the pelvic portion of the vein; or a cirrhosed liver may diminish the calibre of the vein. Any one of these may be a cause of passive congestion of the limb.

The congestion may result from a relaxed condition of the part, or a dilated state of the capillaries. Not unfrequently, inflammation of the acute kind is succeeded by passive congestion in the part, the inflammation having been the cause of the dilatation. The congestion may thus be due to some local defect or disease; or it may arise from some constitutional evil, with or without some local exciting cause. Whatever may have been the cause of the passive congestion, the phenomena by which it is characterized are quite unlike those of active congestion.

Symptoms and Diagnosis.—As the pathology differs from that of active congestion, so do the *symptoms.* To distinguish between them, the surgeon has only to remember the following *symptoms* and *diagnostic marks.* In the first place, the history of the case is widely different. Then the influx of blood, in the passive form, is more general, and the swelling is more distributed. It produces what may properly be called an enlargement—instead of a swelling—which will from time to time be diminished, or will disappear. The pain is not acute, and sometimes is intermittent. Instead of redness, there is often an absence of the ordinary color; sometimes, however, it is increased, but the redness is of a darker hue than is seen in the active form. There may at times be a sensation of unusual heat, but nothing like that burning sensation which

belongs to the active form. The function of the part is more or less deranged; this necessarily ensues upon the dilatation of the venous capillaries. The progress of the blood through them is very slow, and consequently the arterial blood cannot flow into the part, even to supply nutrition. Function is thus deranged, and ultimately vitality of the tissue is impaired. That continued passive congestion does impair the vitality, is shown very often in chronic ulcers of the legs. (*Vide* Ulcers.) If from any cause the tissue is injured, the powers of nature fail to repair it as in health.

Passive congestion may be called a local affection; at least, for some time, it gives rise to no constitutional symptoms. There is nothing like irritative fever, such as is seen in active congestion. If, however, the disease continue for a long time, general weakness, failing appetite, and sleeplessness, may be expected to result.

Results of Passive Congestion.—The principal result is *effusion of serum.* The watery state of the blood, its sluggish movements, as well as the weakened state of the tissue, favor transudation through the coats, producing dropsy or anasarca.

Softening of the tissue is another result. (*Vide* Softening.) And the tissue may undergo also other *deteriorating changes.*

Treatment.—In no case of disease is the principle that it is necessary to remove the cause so apparent as in this. If there be any obstruction to the venous flow, it is of paramount importance to have it removed; and then, if the congestion be not of long standing, restoration will soon follow. Again, if the disease is connected with a toneless condition of the tissue, endeavor to ascertain what was the cause thereof; and then, to effect its removal, understand whether the fault lies in the tissue of the part, which therefore does not possess the power to appropriate from the blood to maintain ordinary repair, or whether the blood itself is deficient in the necessary vital elements. If a satisfactory conclusion can be arrived at relative to these questions, the course of treatment to be pursued will be surely indicated.

Speaking generally, the treatment will be both local and general. The bloodvessels are dilated, and will be benefited by external support. In case of venous congestion of a leg, a bandage applied in the morning, before swelling takes place from the blood gravitating, will prevent its taking place, and often, after a time,

even effect a cure. The bandage must, of course, be applied from the foot, so as to make the pressure equal. An elastic stocking may be advantageously used instead, thereby obviating the necessity of the daily attendance of the surgeon. Yet a nurse may be taught to apply it.

Position is another important means by which the congestion may be controlled. As blood will gravitate to the part, so it may be made to gravitate from it. Bathing and friction must not be neglected.

The *constitutional treatment* must be tonic, of which, preparations of iron will be found the most serviceable; also the iodide of potassium. In the treatment of passive congestion of the spinal cord, Dr. Brown Sequard highly recommends belladonna, and ergot of rye. The former, he has found by experiments on the lower animals, has a very decided effect upon the unstriped muscular fibre. It may be given internally, or applied externally in the form of a plaster. I have used it to great advantage in passive congestion of the leg. In the treatment of chronic sores, I use the extract, to which water is added, so as to form a lotion. In some cases I have added Tinct. Ferri, by which the lotion was evidently made more potent. (*Vide* Carbuncle.) It is hardly necessary to say that due attention must be paid to diet.

Chronic Inflammation.—So called, often after acute inflammation has existed in a part. It may be gradually superseded by a pathological condition, which, although commonly known as chronic inflammation, possesses very few of the features of inflammatory action. Indeed, when such features do show themselves, they may be regarded rather as a returning to the primary action. The chronic disease seems from time to time to create inflammatory action—perhaps even produced it in the first instance.

Causes.—Are general and local. In every case, a general or predisposing cause may be said to have been in operation. Sometimes two or more predisposing causes have acted conjointly. These general causes may be some morbid condition of the blood, or of the tissue; either may have been of long standing, or of recent existence; and they may be hereditary or acquired. The more potent the general cause or causes, a less exciting cause will be adequate to produce the disease. Chronic inflammation bears almost the same relation to passive congestion as true inflammation

does to active congestion. In one case, the action is governed in a great measure by physiological laws; in the other, it is all abnormal—pathological. In the one, efforts to heal are manifested at every step; in the other, these efforts are absent, or are of the most futile kind.

Local Symptoms.—The local symptoms of acute or healthy inflammation are *pain*, *heat*, *redness*, and *swelling*. Now, if we examine the local symptoms of chronic inflammation, which are analogous to those of the acute, we shall find that they are indeed but the *analogues* of healthy inflammation. The *pain* is rarely great, as the swelling is slow in taking place, and the nerves are never made acutely sensitive. *Heat* is never increased to an appreciable extent. *Redness* is not generally well marked; it may be present, and, when it is, the hue is much darker; there is not that bright arterial color which is seen in acute inflammation. The *swelling* is generally greater, not, however, always so. It is more diffused, and is due to effusion of serum.

The resemblance between the constitutional symptoms of chronic and acute inflammation is even less. Inflammatory fever, with its various characteristics, is never seen. The excretions are not arrested. Where fever is present it will be in the form of hectic. There may be great debility, due to the disease itself, or to some pre-existing condition of the constitution, which, indeed, may likely have been the cause of the disease.

Products of Chronic Inflammation.—As would naturally be supposed, from the pathological state of the part, *serum* is the principal product. With the serum, however, fibrin is often poured out; but it is limited in quantity and deficient in vitality. Its power to organize is far less than that witnessed in the fibrin of acute inflammation; and, when it degenerates into pus, it is also below par; it is not laudable pus.

The *liquor puris* is in excess when compared with the cell constituents, while at the same time the cells are wanting in the characteristics of pure pus.

I have said that at times the disease will give place to action of an active kind, during the continuance of which the features of true inflammation will become more prominent. Now, at such times, fibrin, in larger quantities, and with more plasticity, will be effused, and will assume a higher state of organization. In some

cases these periods of active disease will be of frequent occurrence, or it may be that, simultaneously, chronic action may exist in one part, and active disease in another. The result of this will be that fibrin of a more organizable character will be effused; and, in consequence of the very chronic disease which is coincident, it is enabled to assume a high state of development, that is, for a material such as it. It is in such cases of chronic inflammation that a tissue or organ is seen to become enlarged. The adventitious material becomes incorporated with the natural, constituting false hypertrophy. Sometimes, again, while this process of organization is taking place in one part, in another the lymph may be degenerating into pus. The irritation in one place leads to the continued formation of pus; in another to the existence of false hypertrophy. These widely different proceedings, although coincident, will indicate how abnormal is the action; how far separated from healthy action is chronic inflammation, so called. The occasional attempts to cure but show how incapable is nature, unaided, to accomplish the work.

Treatment of chronic inflammation may conveniently be divided into general and local. Sometimes the local disease will demand immediate attention; but, while such is being given, the constitution will also require particular attention. In most cases, however, the order will be reversed, the constitution must receive the first attention. After it has been brought into as healthy a state as can be, then local treatment will be more likely to have effect; yet, in the mean time, the local symptoms should be palliated.

In all cases the treatment must be supporting. Whatever may be said in support of depletory measures in acute inflammation, no ground can be found upon which to base such treatment in the disease now under consideration. Tonics, and often stimulants, will be diligently used. Diet of the most nutritious and digestible kind will be given.

The *local treatment* bears a closer resemblance to that of the acute. *Counter-congestion* will not prove so beneficial; but *local depletion* will generally be serviceable. It draws away the venous blood, and relieves the distended vessels and the intervascular substance. Blisters are of more certain value; by their use a large quantity of the serum will be drawn off, likewise giving relief of an important kind, inasmuch as serum constitutes the principal

product of the disease. Of still greater value in many cases is the formation of a discharge, as by the issue or seton or moxa. The benefit of these is strikingly exhibited in chronic inflammation of the knee or hip joint. In these diseases, a blister kept running for a lengthened period, or a continued discharge maintained for a long time, will, by diverting nature, attract from the seat of disease the superabundance of blood; so that the tissue may thereafter recover itself, other circumstances being favorable. In all cases rest to the part must be strictly secured, which alone will often be sufficient to effect a cure. (Hilton.)

CHAPTER XIII.

Chronic Abscess—Results—Treatment—Sinus or Fistula—Treatment.

Cause.—Chronic abscess is a very common result of chronic inflammation; it is called *chronic*, however, because the pus collects very gradually, as well as very stealthily; generally without pain or other symptom to warn the patient, or tell the surgeon of its existence. A chronic abscess may result from the acute, as well as from chronic, inflammation. Sometimes the inflammation having subsided, there will exist, as a product, a quantity of coagulated fibrin; this may subsequently become a source of *limited* irritation, leading to the gradual formation of pus. Again, tubercular matter may have been deposited in a tissue and have become a source of slow suppuration. And again, a comparatively slight injury may have produced effusion of a quantity of lymph, with or without a little blood, which, although coagulated, failed to become organized; and which, after a little, gradually degenerated into pus.

Pus.—The *pus* of a chronic abscess is never laudable. It will have character given to it by any constitutional evil that may exist, but it is always thinner, more watery; the *liquor puris* being in excess, while the corpuscles are deficient in that vitality which is seen in pure pus.

Symptoms.—The *symptoms* differ widely from those of acute

abscess; yet enough resemblance exists to warrant the use of the term abscess. In acute abscess there is always pain, sometimes of the most excruciating kind; but, as before said, there may be none to mark the commencement and increase of the chronic abscess. The reason is plain; the pus, forming gradually, does not cause that sudden pressure, so that the parts may accommodate themselves to the forming material, which could not be done if the pus were suddenly collected; and thus irritation, pain, and inflammation do not come in a train. The extent to which the body or a single part may become accustomed to the presence of a new formation, such as a tumor or a collection of pus, when the growth takes place slowly, is very remarkable. The tissues encroached upon give place, will first be pushed aside, and afterward undergo absorption; so that but a feeble, or perhaps no warning voice is heard, to tell of what may be a grave malady, leading to destruction of important parts.

Diagnosis.—Very often a large abscess will form, or a tumor grow to a large size, and its existence be unknown, or at most but suspected, until it shows itself externally. And when an abscess is discovered by the eye it is not always easy to *diagnose* it from a growing tumor, or a chronic hernia, or an aneurism. The location of a hernia is only likely to be where protrusions can the most easily take place; and an aneurism can only exist in the course of an artery; and so far safe assistance is obtained in making a diagnosis. And upon these circumstances and the history of the case the surgeon will have principally to depend. When pus approaches the surface the sense of fluctuation will afford great help; but it must be remembered that fluctuation is sometimes present in an aneurism, particularly at its first formation. It would be a frightful mistake to cut open an aneurism; and should the surgeon feel disposed to pursue the treatment of opening an abscess, and yet have some misgivings as to its nature, he ought by all means to wait. In this connection I am reminded of a case which came under my notice in the country, in consultation. It was an obscure swelling in the abdomen. The physician, under whose care the patient was, had diagnosed an abscess, and wished to make an incision through the intervening tissue. This procedure was objected to by two others in consultation. The patient ultimately died, when a *post mortem* revealed that the tumor was

produced by an encephaloid growth of the kidney. Had the physician, who was one of some forty years' practice, made his incision where he proposed, he would have cut through the omentum and colon.

Prognosis.—Will necessarily depend upon the region in which the abscess is located; the tissue involved; the original cause; the constitution; whether afflicted with any special disease; the age; and the surroundings of the patient.

Results.—*Resolution* may take place, or the pus may find its way through the tissue and be discharged. That resolution may be possible, the source of the constantly collecting pus must be dried up—the cause of its formation must be removed. There is always, surrounding the pus, a well-developed pseudo-membrane; this is formed in part by condensed cellular tissue, and in part of organized lymph. It, after a time, is well supplied with blood-vessels. The lymph which separates from the blood in this surrounding false membrane, quickly degenerates into pus, and is added to that within the walls. The amount of pus thus formed will, of course, depend upon the degree of irritation. The membrane is called the *pyogenic* membrane. Now, supposing the pus ceases to be formed, can that within the membrane be removed by absorption? The belief was held for a long time that it could not; at least such was believed by many, and such was taught when I was a student. But the teachings of Hilton, in his recent lectures, are so plainly to the contrary, and are so well supported by the record of several cases, that no doubt can be entertained as to the ability of nature to remove it. The same membrane which had seemingly secreted pus, assumes a new office,—that of absorbing the pus; and as *liquefactive degeneration is consummated, the work of removal may be completed,* and finally the walls of the abscess will be collapsed, join together, and become united by adhesion, thus completing the process of resolution. But the work does not always progress uniformly. Oftentimes the cause of suppuration will recur, and for a time pus may again be degenerated. This may occur many times before the abscess is finally resolved.

In a good majority of cases, perhaps, the contents of the chronic abscess gradually finds its way to the surface of the body. The process by which this is done is identical with that described

as the process of pointing in acute abscess. Through an opening thus made by nature, the pus will slowly discharge, and, under favorable circumstances, the walls will coalesce, and unite by adhesion, or the space fill up by granulation. In every case, when the pus is gradually removed, either by absorption or by discharge, the structures which had been pressed aside will slowly resume their natural position.

Sinus.—In some cases, after the pus has discharged, healing, neither by union nor granulation, will take place, but the abscess will shrink up, so as to be very small; yet it will not heal. Leading from where had been the heart of the abscess to the place where the exit of pus had been made, is a canal, called a *sinus*. The pyogenic membrane which had lined the abscess now lines this canal, and is, perhaps, possessed of a higher degree of development, and bears a certain resemblance to mucous membrane, in its power to secrete and absorb. (*Vide* Fistula.)

Treatment of Chronic Abscess.—The surgeon will not be in a hurry to open the abscess. The fact must not be forgotten that the contents may be absorbed. By making an incision, the pus will at once be got rid of; but, unlike in the acute abscess, this sudden discharge is not unattended with danger. It is an important practical fact, that very often, after this quick escape, exhaustion of the patient's strength follows, with hectic symptoms, terminating in death. This serious result has commonly been attributed to the entrance of air, and such may undoubtedly be the case. The pus, suddenly escaping, leaves a space which will be occupied by the air, ready to rush in; and this air, in a short time, may so act upon the matter as to cause chemical changes—decomposition, indeed—by which the system will become quickly and seriously affected. It is not the irritation of the air as such, but the result of the changes which it produces in the pus. Those who have seen chronic abscesses treated by incision and by immediate pressing out of the pus, and perhaps thereafter closing of the wound, will have noticed that in a few days, when a second discharge took place, the pus had become much more offensive than at the first.

This great danger, then, which follows such treatment, will lead the surgeon diligently to consider whether a safer course cannot be pursued. And inasmuch as the pus may be absorbed under

certain circumstances, to attain that, attention will be directed. This is a safer procedure, but it is a tedious one, and will not necessarily be adopted in every case. If the abscess is superficial—that is, has arisen in a superficial tissue—or if an important organ is not involved, the quicker course may safely be pursued.

It may not be impossible to remove a portion of the contents of the abscess in the manner recommended by Abernethy, by which the entrance of air is prevented; but there is, as a general thing, a new supply of pus in a short time, unless the cause of its formation be removed. I have enjoyed the opportunity of seeing treated, and of treating, a large number of chronic abscesses. Among those I have treated were some of the abdomen, of the pelvis, and the psoas abscess. The course of treatment I adopted was as follows: The abscess having approached near to the surface, I made a direct opening into its cavity. The incision was not large, nor yet small; it was just large enough to allow the escape of as much pus as would relieve the pressure due to the accumulating matter. Care was taken to allow only so much to escape as the *tissues would force out.* It will be remembered that the structures have been pushed aside by the abscess. In these structures there is naturally a tendency to return to their natural position. Now, if the pressure cease, this return may be expected to take place; and not only that, but they will gradually press out the pus, if it have a way to escape. Hence the propriety of the treatment. An opening is made, which must not be allowed to close; yet no tent should be introduced. Squeezing out of the pus is strictly avoided, and the tissues are allowed to regain their natural relationship, by which the pus is expelled, and the walls of the abscess gradually approximated. Before making the incision, the patient was placed in a natural position; because, after the opening is made, a change in the position of the body would force out the matter sooner than the tissues could regain their original place, and consequently the entrance of air would necessarily follow. A poultice was always applied at once, which soothed the part, and also tended to keep open the wound. Within twelve hours, if the wound had closed, it was gently parted by the probe. This course of treatment I can confidently recommend to the attention of the profession. (Hilton's method of opening.)

But I would not recommend it to be practised to the exclusion of that based on the fact that pus may be gradually removed by the absorbents, and that to secure the possibility of such taking place, the part should constantly be in a state of *rest*—enjoy freedom from disturbance, mechanical and physiological. (Hilton.) But when it is seen that a cure by absorption will not be accomplished, then an opening ought to be made in the most depending position, either with a knife, or as recommended by Hilton.

Sinus, or Fistula.—By this is understood an abnormal channel in the tissues, with an opening at one or at both extremities, and lined by a pseudo-membrane similar to that which lines the cavity of a chronic abscess. It has elsewhere been explained that a sinus may result from an abscess; it is, indeed, the most common way in which it forms. It may, however, be due to other causes. Sometimes the duct of a secreting gland becomes occluded, and the secretion, having collected, will after a time seek another channel, which will be made through the agency of inflammatory action. In due time, the canal made will be lined by a false membrane, secreting pus. The fluid, continually flowing along this abnormal passage, is a source of irritation, and hence the continued formation of pus. Again: in the rectum, ulceration sometimes takes place through its coats, and through this the fæces make their way into the tissue without the rectal wall. Inflammation results; the pus and fæces burrow into the deeper structures, and often downward along the course of the rectum, and finally to the surface of the nates. The matter having been discharged, there remains a sinus, or two or more sinuses, lined by a false membrane. The fæces continuing to pass into and through the new channels, there is continued irritation at each act of defecation. The parts, therefore, cannot heal; but pus is steadily elaborated. Again, a fistula may result from a penetrating wound, which, because of motion, cannot heal; or because a foreign body is lodged at the bottom of the wound, and which precludes the possibility of healing taking place.

These sinuses may continue for an indefinite period of time, simply because the irritation continues.

Treatment.—They were formerly, and I fear are even yet by some, treated almost invariably by stimulating injections, the object of which was to create a more healthy action. Tincture of

iodine has been a favorite injection. It was generally deemed necessary to destroy the false membrane, and sometimes a quicker method than the above was adopted. To do the quick work, a piece of caustic was thrust in and brought in contact with every part of the false membrane. The false membrane being thus destroyed, it was hoped that healing by granulation would follow. Sometimes a seton, or a piece of lint, was introduced for the same purpose. When these means failed, a director was introduced, when possible, along the track, and a bistoury, probe-pointed, made to follow it, and then divide the tissue intervening between the sinus and the surface. Of all the foregoing methods of treatment, the last is the only one that can be recommended. The others are worse than useless. We have before learned that if the surfaces of an emptied abscess be brought together and retained so without motion, they will unite together as do the surfaces of a wound. It will be the same with the walls of a sinus: if held immovably together, they will also unite. The lymph which had degenerated into pus heretofore, will constitute a bond of union, by which the healing will be accomplished. It will be understood, then, that the false membrane ought not to be destroyed; that it is, indeed, useful, inasmuch as speedy healing may take place by adhesion of the walls. The treatment, therefore, consists in removing every cause of irritation, and thereafter maintaining the parts in a state of perfect quietude.

Motion, either incessant or periodical, may be the only cause of the irritation.

How can the parts then be kept at rest? In some cases it is almost or quite impossible to do so; and the only way, as in fistula in ano, is to divide the muscle. In the case of the fistula in ano, every time the bowels are moved, the sinus is disturbed by the action of the sphincter ani, and, as the action of this muscle cannot be arrested, the only course to pursue is to divide it, after which the sinus may be expected to heal by granulation. But in other parts of the body a fistulous track may be so kept at rest as to allow union to take place; to secure this the best efforts must be made, and this may more frequently be done than is generally supposed. To elucidate this subject and impress it with high authority, I must refer to the interesting and important cases reported by Hilton. He speaks of abscesses and sinuses in various

parts of the body, as the occipital region, the cervical, under the platysma myoides, and under the sterno-cleido-mastoideus, in the groin, popliteal region, &c., where a cure was effected by simple attention to *rest*, preventing motion in the part.

At the time I read the lectures in the "Lancet," I had under my care a patient, a German, whose case seemed a suitable one upon which to test the principles. When he first consulted me I was informed by him that he had "scrofula," and that he had been under the treatment of several surgeons, who had tried a variety of remedies in vain. I found the opening of a sinus near the angle of the jaw on the right side. The probe could be made to pass readily beneath the integument up nearly to the ear, and also deeply backward under the sterno-mastoid muscle. For the space of an inch around the orifice there was the livid appearance characteristic of such sores. His constitution was in every way sound, there being no indications of scrofulous disease, and I concluded that the cause of the continued discharge must be sought in the part. I could scarcely believe that the motion consequent upon eating was sufficient to maintain the disease, and therefore looked for something else; and I had not to look far. Frequently meeting him in the street I had noticed that he invariably held a cigar in his mouth, and seemingly with great firmness, so as to create an appearance of tenseness in the region of the sore. He admitted that he almost always, when awake, had a cigar in his mouth. I at once decided in my own mind that here was the cause of the trouble. Having explained to him my opinion as to the cause of the continued annoyance, he promised thereafter to confine himself to at least periodical smokes. I at the same time applied adhesive strips around the part, for the purpose of fixing the muscles and fascia. In a few weeks there was decided improvement. The discharge was less than it had been for years. Subsequently I thought that if collodion were freely applied around the part, so as to fix the tissue more firmly, and press together the walls of the sinus, the result might prove beneficial. This treatment proved very successful, and, although he could not or would not refrain from smoking, as I had urged, nevertheless, in a few months the sinus had quite healed.

When a sinus cannot be retained in a state of rest by pressure, or by collodion, there seems to be no alternative; the bistoury

must be used, and the parts divided. But it must not be forgotten that this division of the tissues secures the grand desideratum, *rest*, and allows the opened sinus to heal by granulation. Could that rest be secured without the division, there would be all the difference which exists between healing by adhesion and that by granulation.

CHAPTER XIV.

Pyemia—Causes—Treatment—Softening—Ulceration—Sloughing—Gangrene—Treatment.

Pathology.—This is a diseased condition of the blood, and is attended with profoundly evil symptoms, and too often followed by fatal results.

Some product of inflammation becomes intimately admixed with the blood, by which that fluid is literally *poisoned;* and which, in turn, involves the whole system in disease, often, as I have said, unto death.

It was formerly understood that pus was the material which had found its way into the volume of blood. But there seems to be some reasonable doubt respecting this question. There are only two ways by which pus could enter the circulating blood: by absorption, or through the veins when accidentally divided; or when it has formed within it. Respecting the first, we have learned that pus-cells are too large to be capable of passing through the coats of the absorbents; and that, when purulent matter is removed by absorption, a prerequisite to its taking place is the breaking down of the pus-cells. Moreover, it is a fact to be remembered, that large quantities of pus are often absorbed without any constitutional effects whatever presenting themselves, without any sign of pyemia. The worn out, or perished cells, are eliminated without any perceptible evil. We look here, then, in vain for an explanation of the problem.

Again, it has been supposed that when veins are divided there is an open way for pus to enter the blood, should it form in that part; forgetting, as a writer has said, that if such a way were open

for pus to enter, by the same way blood would certainly escape; yet, in cases of pyemia occurring in connection with wounds, there is no sign of hemorrhage. Probably the fact that pyemia very frequently follows phlebitis, has led to the conception that pus has directly entered the circulation. But the objection referred to seems to be fatal to the theory. But may not pus be formed in connection with inflammation around the coats of a vein, in consequence of which a separation of fibrin from the blood takes place within the vein? Here, again, actual observation has shown that such is very unlikely to occur.

The primary effect of the inflammation is the formation of a clot of fibrin around the vessel and within it; and when inflammation extends and suppuration ensues, even within the vein, it will be found that the clot extends along its course, so that a barrier of clotted fibrin always exists to prevent the entrance of pus into the blood. Likewise, when a vein has been divided, the clot will close up the wound, and very likely occlude the vessel to a greater or less extent. The formation of these clots in inflammation does not seem to be due entirely to the inflammatory action. To beget this disease there seems to be some peculiar condition of the blood, or its fibrin, which renders it easy of coagulation. There is a deficiency of vitality, which is manifested by a speedy coagulation; and, subsequently, an equally speedy disintegration of its substance. And here seems to be the most plausible explanation of the disease. Here is its pathology. The clot does not disintegrate in a body; but its boundaries, which are constantly washed by the venous current, break away particle after particle, until the whole mass is floating in the circulating blood in the form of minute particles of dead matter, which may continue to undergo decomposition. It is this material, thus introduced into the blood, which affects so disastrously the vital fluid, which acts as a rank animal poison to it and the whole system. Thus it will be seen that pyemia is not due to the admixture of pus, but to a more noxious agent; that, while it is derived from the fibrin, yet it is not a degeneration of that substance into pus, but an actual death and disintegration. Perhaps it is not in every case an actual death; but at least it is a degeneration far more degrading than that of pus. Virchow says, "It is a puriform, but not a purulent substance."

Causes of pyemia may be divided into *predisposing*, and *local*, or *exciting*.

Among the predisposing causes are other diseases of the blood, such as prostration from organic diseases, as in lung and kidney affections, diseases of joints, exhaustion from surgical complaints, accidents, amputations, shocks, parturition, unhealthy occupation, and over-indulgence in food.

Local causes most frequently are some injury, by which the vein tissue is much involved; severe lacerating wounds, of the leg particularly. Anything, indeed, which causes inflammation of the veins. It is a common sequence of gunshot wounds.

During the progress of the American war, pyemia has been of very frequent occurrence. Whilst sojourning in the Army of the Potomac, after the battle of Chancellorsville, and afterward in the Lincoln Hospital, at Washington, I had the opportunity of witnessing the course of not a few cases. No doubt camp life, especially to the recently made soldiers, and the excitement as well as the toil of forced marches and of battle, constitute very potent predisposing causes of the disease. And very *active exciting causes* of the malady I conceived to be, from careful observation, the protracted, painful, and often ruthless examinations made, to find balls, which were supposed or known to be imbedded in the tissues, and the injudicious efforts made to recover them. Examination by the finger was unhesitatingly resorted to and continued for some time. As a result of this there could not be otherwise than laceration of tissue, a breaking up of fibrinous adhesions, which nature had made in her anxious efforts to heal, and which then would speedily degenerate or die, thereby producing the material which we have seen leads to the disease. I could account in no other way for the fact that patients who had been placed on the operating table with no single unfavorable symptom "for examination," and who had been subjected to a long-continued and extensive examination, terminating sometimes in the abstraction of a ball, often without discovering it, would the same evening have a chill, and two days after have all the symptoms of pyemia, and upon the third or fourth day would die. I was convinced, in my own mind, that it would be better for the patient were the ball never searched for, unless in cases of comminution of bone.

Resulting from this blood-poison may be expected, in most

cases, secondary deposits in the capillary structure. The detritus of the clot which has become mixed with the blood, will fail to pass through these small vessels, but, becoming lodged will set up a low form of inflammation, followed by the formation of numerous small abscesses. It is, of course, in the venous blood that the morbid material first floats when it leaves the site where the clot had formed. It therefore passes immediately to the heart, and thence into the lungs. Here, then, are the first capillaries through which the *debris* attempt to pass; and it is here where the secondary deposits by far the most frequently occur. Having passed through the lungs, the next structures in frequency to become the site of deposit are the brain, liver, kidneys, and joints. (Syst. Surgery.) In connection with the secondary deposits, or arising therefrom, will be seen an asthenic action in the whole capillary structure of the body, characterized by an œdematous condition. I have observed this more particularly in the lower extremities, which resemble anasarca, only that there is less pitting on pressure. It would seem that the coats of the minute vessels lose their tone, and consequently exudation of serum and fibrin is favored, into the cellular structure.

Symptoms and Diagnosis.—*Symptoms* of pyemia are, as a general thing, well marked; consequently, the *diagnosis* is never difficult. The history of the disease is important to assist in the diagnosis, inasmuch as the disease comes on after some injury or operation.

If a wound is suppurating, it will be seen, as the disease is established, to cease discharging, and to become dry. Soon thereafter, the skin and the secretory organs generally will cease to act; but afterwards there will be a clammy moisture of the skin, and diarrhœa may set in. The disease is ushered in by a chill, which will be repeated from time to time. The pulse will be quick and uncertain, and compressible. The tongue will have a typhoid appearance; indeed, many of the symptoms are the same as characterize typhoid fever. In addition to these symptoms, others may present themselves, depending upon circumstances peculiar to the case.

Treatment.—The *local* treatment will consist in the application of warm fomentations, or poultices, with the view of re-establishing the discharge and preventing, at least of limiting, the entrance

of the poison into the circulation. When the secondary deposits give rise to local inflammation, the treatment will be on general principles.

The *constitutional* treatment will be directed to the elimination of the blood-poison, and to sustaining the strength, which will rapidly decline. The skin, kidneys, and bowels should, as far as possible, be kept in a healthy state of action. Medicines cannot be found which possess any specific power to neutralize the poison. Such only should be given as will tend to aid in the elimination of the morbid material, or give tone and strength to the stomach, that nourishment may be advantageously administered. Stimulants ought from the first to be freely and frequently given. Everything, indeed, will depend upon the ability of the stomach to bear nutritious food and drinks, as well as judiciously administered stimulants.

Pathology—Softening.—We have elsewhere seen that softening of tissue, in connection with inflammation, is one of the many efforts constantly made to cure, at every step of the inflammatory process. This is more particularly seen in connection with the formation and pointing of an abscess. This softening has been likened to that which accompanies or precedes parturition, by which the soft parts are prepared for the transit of the child into the world. And certainly the two processes are much alike, nature seeming to be adequate for the requirements of both cases. In parturition, the more complete the softening—the relaxation—the more speedy the labor, and the less suffering. Likewise in inflammation: when there is softening and yielding, and therefore swelling, the pain is less, and the danger diminished. So far, softening may be regarded as a physiological action; but in many cases it becomes a disease. The softening may be too great, and more extensive than is requisite to subdue the inflammation. This may arise from a previously dilated or weak condition of the part, or of the whole system. Improper treatment is not unfrequently the cause of undue softening. Position, or any application that induces passive congestion, may become a cause of softening. I have in a great many instances seen long-continued poulticing, and other relaxing applications, lead to disastrous softening. Certain tissues are more subject to softening than others: as the brain; spinal cord; bone; synovial membrane, &c.

Results.—Degeneration will inevitably result from softening (*vide* Diseases of Joints), and the tissue will often become much thickened. Again, ulceration is a frequent sequel. These, then, are the *results* of softening: *degeneration*, *thickening*, *ulceration*, also *absorption;* besides, the *system* may become affected, leading to exhaustion and death.

Treatment of pathological softening will consist, mainly, in removing the cause; to do which, a distinct knowledge of the pathology will be essential. Relaxing applications must be discontinued, and everything which may induce passive congestion or pressure must be removed. The constitution will be treated according to circumstances.

Ulceration is akin to softening, or may be considered a further step in the same pathological changes. It is desirable to have a distinct meaning attached to the term ulceration. Some confusion I have found to exist, in consequence of the term "ulcer" being employed synonymously, when its proper use is in connection with quite a different thing, although the two may coexist. An *ulcer*, it may be stated here, is a sore—a solution of continuity upon a surface, which nature is attempting, successfully or otherwise, to heal. If the effort is successful, it is a simple ulcer; if unsuccessful, it becomes an unhealthy ulcer. But *ulceration* is always a *pathological* action: it signifies destruction—actual death of tissue; only, that instead of a large portion, a perceptible quantity, perishing, it is by particles. Molecule after molecule softens, dies, and is steadily carried away by the absorbents, and eliminated from the system. In health, there is a balance maintained between decay and the building up of tissue; if, however, the decay is greater than the repair, then there is an excess of molecular death, and there will be a diminishing of the tissue. Sometimes this occurs in a whole organ, and constitutes atrophy. When it takes place in a part, it is ulceration. Like softening, it often comes under the surgeon's notice as a curative operation. (*Vide* Pointing of Abscess.)

Ulceration is sometimes rapid. If the tissue be predisposed in consequence of natural weakness, or from an injury, by which its vitality is impaired, molecular death will more readily and quickly follow any exciting cause. Again, the application of a poison

may hasten molecular death; also, when it has entered the system, it may constitute a predisposing cause.

The causes, then, are predisposing and exciting, both of which may act together.

The *treatment of ulceration* is obvious. Ascertain the cause, and remove it; or if that be impossible, endeavor to lessen the effects. When the process of ulceration has been stayed, healing ought to supervene; but very generally the system—the blood—is impaired, and disqualified for supplying proper reparative material. Attention will therefore be directed to the general health, as well as to protecting the part where destruction has taken place.

Sloughing.—Closely allied to the ulcerative process, is sloughing. In this, however, the destruction of tissue is more rapid and extensive. It perishes, not by atoms simply, but in larger portions, though not in a mass, as in gangrene. Sloughing is often seen to follow a severe bruise. A crushing force has mechanically disturbed the physical substance, and the vitality of every atom is quite, or almost, crushed out, the coats of the vessels no longer possessing the power to discharge their functions. The blood passing to the part does not permeate it, although it gives to it a quantity of the watery element. There is but the faintest resemblance between this process and that of inflammation; it is this which alone distinguishes sloughing from gangrene.

Sloughing may also be caused by some violent poison: as, for instance, when syphilitic poison of a virulent kind comes in contact with the glans penis. Its effects are often immediate, like a corrosive poison, before absorption can possibly have taken place. Any one who has walked a syphilitic ward will have seen instances where in a short time the whole of the glans, and even more of the organ, has sloughed away. No doubt, absorption begins to take place; but the vessels, in the very act, receive their death-poison. Continued pressure, with undue heat, especially in a constitution weakened with disease, often causes sloughing, as well as gangrene. Instances are to be seen in the form of bed-sores, where the patient has been confined to bed for some time—more particularly from exhausting fevers, or other like affections. In every case, when the system is below par the effect of the exciting cause will be greater.

The sloughing process endangers the whole system. The dying tissue and juices therein, if taken up by the absorbents, cannot but produce evil effects upon the constitution; and the more extensive the local disorganization, the greater will be the probability of general complication.

Treatment of Sloughs.—Will necessarily depend upon the cause and the amount. When due to an injury, and the system is healthy, but little is required to be done. (*Vide* Contusions.) When, however, the sloughing results from a poison, treatment of the most active kind must be adopted; in most cases, the surgeon must act promptly—almost heroically. The diseased tissue (that in which the poison is lodged) must be separated from the sound as quickly as possible, so as to limit the destructive process. The most certain way is to freely apply a caustic to the part in which the virulent poison is so speedily destroying the vitality. By destroying this tissue, the poison may also be destroyed, or rendered impotent for further evil. While the poison is yet upon the surface of a tissue, this is a sure as well as a quick way of staying the disease. In a manner almost similar, the poison of gonorrhœa may be destroyed before it has actually caused the inflammation, by applying a solution of nitrate of silver; also the poison of dissection. In urgent cases, nitric acid will be needed. Its action is prompt, and I have often seen it applied with advantage to sloughing tissue. It destroys the substance, and the poisonous action is arrested. Bearing in mind the object to be secured, it will be understood that every bit of the tissue involved must be reached by the caustic, and that it will be better to destroy too much than too little. Occasionally, even a large amount of substance will have to be sacrificed; but when the exigencies of the case demand it, there can be no hesitation: it is destroying a part to save more—perhaps life itself.

When the constitution was primarily involved, or has become so as a consequence of the sloughing, stimulants will be demanded to bring the system up to par; and then tonics and generous diet, to retain it in that condition.

This supporting treatment will be particularly demanded when the surgeon has to treat *bed-sores;* while locally, some disinfectant, as a charcoal poultice, will prove useful.

Gangrene.—This is death of tissue in substantial portions, not

in molecules, not in sloughs, but in masses; by it a member of the body, as a toe, or a hand, or a leg, may at once die.

Causes.—There are *predisposing* and *exciting* causes. Now there is no difficulty in understanding that if the feeding vessel to a part be divided or occluded, so that the part is no longer supplied with blood, and heat no longer is generated, that it must inevitably perish. But this cause of gangrene is not always so quick in its effects, nor so perceptible.

The predisposing causes may be given as follows: 1st. A want of due nervous power, either in the whole system or in the part affected. 2d. A continued want of blood, such as is supplied in health, from which the tissue is weakened. 3d. When the blood is defective in quality. 4th. Long-continued congestion of a part may so derange the structure as to render it liable to mortification. 5th. Certain articles, when taken into the system, will favor or actually produce gangrene; the most notable of these is ergot of rye. 6th. Old age.

Direct Causes.—1st. A very common one is the formation of a clot of fibrin in the heart or elsewhere, which, being dislodged, is carried along in the arterial stream until a point is reached beyond which the clot is too large to pass; and it there effectually closes the tube and cuts off the supply of blood. 2d. In a similar manner gangrene is sometimes caused by the ligation of an artery. In these cases of sudden occlusion the danger is great, if collateral circulation, which is essential to preserve the limb, cannot be immediately established. 3d. A growing tumor, by pressing against the artery, may arrest the flow of blood therein. In this way internal necrosis of bone is sometimes produced by even a small tumor pressing against the nutritious vessel as it is entering the foramen. 4th. Frostbite is a common cause of gangrene; the intense cold destroying the vitality beyond recovery. Under the influence of the cold the blood ceases to enter the tissue. (*Vide*, Frostbites.) 5th. Intense heat in the form of burns or scalds.

The terms *moist* and *dry* gangrene, also *acute* and *chronic*, are often used. Moist and acute are the same, and dry and chronic are the same. In the first the death takes place quickly, the fluids still existing in the part; and, consequently, the gangrenous substance is moist. When the gangrene takes place more slowly, the fluid escapes from the part, the blood having ceased to flow some

time before. Hence the fact that gangrene is at once chronic and dry or shrivelled. The latter is more frequently seen in the aged. The terms idiopathic and traumatic are also sometimes used, but do not require any special interpretation.

Treatment of Gangrene.—The remarks made respecting sloughing will, in many respects, apply in connection with the treatment of gangrene. The part which has perished must of course be separated from the living tissue. To do this nature always sets promptly to work and hastens to complete it. The process of separation is supposed to be accomplished by, 1st, softening taking place in the tissue still living, and which it may be supposed had not escaped altogether that which caused death in the contiguous tissue. The state of gangrene seems to accelerate the adjacent softening. 2d. Following the softening is ulcerative absorption. The line of demarcation is gradually fixed, and the separation is slowly consummated. While some tissues are easily separated under such circumstances, others are slow to yield to the ulcerative process.

It is a question of some importance whether, during the process of complete separation, any of the dead substance is ever removed by the absorbents. That such may take place might reasonably be inferred from the fact, that for some time after the other tissues are quite divided, vessels remain unsevered; and, although blood finds no tubes to traverse in the dead substance, the powers of absorbing may continue. In this way it is possible that a thin stratum of the gangrenous substance may be removed. Yet it is more probable that the division is made at the expense of the living tissue. When, therefore, there is an extensive surface of gangrenous substance in contact with living tissue, as the greater part of a limb, the sooner the gangrenous mass is separated the less danger is the system exposed to. On this ground alone it will be seen that surgical interference may become necessary. Although nature earnestly works to rid the body of the mass, she may be poisoned before the work is consummated.

But, in case of a limb being the seat of the disease, there is another reason for interference. In the first place, as we shall see hereafter, the process of separation in the bone is very slow; and finally, when it is consummated, the stump is by no means fitted for active service. The rule, therefore, is, to wait until nature

declares, in terms that cannot be misunderstood, where life still remains; and then, by the knife and saw, relieve her of the weary work, and at the same time secure a serviceable stump.

In those cases where the gangrene is situated on other parts of the body than a limb, and where amputation may not be performed, a different procedure must be adopted. Much can be done to hasten the division and removal of the mass, and to prevent the entrance, by absorption of the poison, into the system. Often, continued poulticing will, by assisting the softening, and by producing a degree of inflammation along the boundary of the territory of the still living tissue, create suppuration, which will have the effect of establishing physiological absorption; that is, the absorption that may take place will be of the living material rather than of the dead. By so treating there will be a greater loss of structure, but it will be attended with less danger to the constitution, and will be more speedily accomplished. In connection with poulticing there must be the strictest attention to cleanliness, and disinfectants should be called into requisition.

The constitutional treatment will be regulated by the rules specified in treating of sloughing, and the remedial measures will have to be more assiduously employed.

CHAPTER XV.

Varieties of Inflammation—Phlegmon—Anthrax—Chilblains—Frostbites—Burns.

Varieties of Inflammation.—Under this head I intend to treat of the various forms of inflammation in which are manifested phenomena at variance with those which characterize acute, or, as I prefer to designate it, healthy inflammation.

Inflammation may be divided into two great classes,—the healthy and the unhealthy. Of the healthy I have spoken, and as well of its products and certain diseases arising out of inflammation. It is of the unhealthy I design now to speak.

Other divisions are commonly made, as acute, subacute, and

chronic, sthenic and asthenic, specific and non-specific. The acute and sthenic are synonymous terms, and may be considered the type of which all the rest are more or less imperfect copies. The subacute is a condition intervening between the acute and chronic, or sthenic and asthenic, and scarcely requires a separate consideration. Chronic inflammation has been treated as a disease arising out of inflammation. The terms specific and non-specific explain themselves. (*Vide* Acute Inflammation.)

The individual diseases now to be considered are phlegmon, boils, and anthrax, chilblains, frostbites, burns, hemorrhagic inflammation, scorbutic, scrofulous, gouty, rheumatic, gonorrhœal, syphilitic, and erysipelatous.

Phlegmon, or Phlegmonous Inflammation.—The term implies that the disease is located in the cellular tissue. As a general thing it presents two distinct forms, the first of which is the common *boil.* A very common cause of this is a local injury, from which exudation of a plastic character has taken place in the subcutaneous cellular tissue. This effusion had rapidly coagulated with but a futile attempt to organize. Contraction attended the coagulation, and the cellular substance was thereby pressed upon, the supply of blood cut off; and all of that involved was doomed to death, in connection with the adventitious material. It is this gangrenous cellular tissue (for such it is, although limited in quantity), and the organized fibrin in its interstices, which constitutes the "core" of the boil, and which is sooner or later expelled by the process of suppuration. Hence it is that boils frequently arise in a part some time after it has been bruised or otherwise injured. The explanation is not difficult. The fibrin being effused, in consequence of the injury, does not at once produce irritation above that due to the injury. But after a time, it, with the destroyed cellular tissue, being a foreign body, creates inflammation, the object of which is to expel this foreign body.

Boils are produced in other ways. The occlusion of a duct which opens upon the surface of the body and leads to a follicle or gland, will result in a collection of the secretion of the small gland. This material will undergo changes, and eventually become a source of irritation and inflammation. Again, when morbid material exists, the object of nature will be to get rid of the foreign substance. These may be presented in the form of small

pimples, or perhaps quite large abscesses, but as a general thing they bear a close resemblance to the boil before described.

This kind of boil is more likely to occur when the blood is in a gross or vitiated state. Such a condition of the blood may be regarded as a predisposing cause of this sort of boil; indeed, they seem often to present themselves without any other cause of an exciting nature.

Treatment.—In the first kind, it must be remembered that a process of detachment has to take place of the cellular tissue, in the same way as when a part has become gangrenous, and that this is to be done by the inflammatory process. This may be facilitated by poulticing, and by hot fomentation, which will also relieve the pain, which is sometimes very great. While this "core" remains undetached, there is no use in opening the little abscess. Probably it is much better to allow the boil to get fully "ripe"—that is, the detachment to be fully completed. If, however, the pain be severe, an early opening should be made. So soon as this is accomplished, and an opening sufficiently large is made, the core will extrude, and thereafter the cavity will quickly heal.

When the boil is due to the closing of a small follicular duct, and the blood is in a gross state, there is no reason for delay in making an opening. The blood must receive attention at first, however, as it is primarily at fault. It is a common practice with some, I know, to give Epsom salts for a length of time, under such circumstances, to "cleanse the blood." Perhaps one or two doses may prove beneficial, by preparing the blood for other medicines. Some preparation of iron should be given. I much prefer the tincture, which will give vitality and purity to its composition. Other measures of a general nature must not be neglected. The local treatment of this boil will be modified by the size and stage. It is always desirable to bring about discussion. They are, when upon the face, more an eyesore than painful, and this really is the only thing which makes it necessary to refer to them. I have used often to advantage, as a local application, tincture of iron, alone and in conjunction with the extract of belladonna. But when pus has actually formed, and seems to be increasing, and very likely undermining, as it were, the integument—when there does not seem to be sthenic action enough to break the skin—then an incision should be made. By this procedure, the deformity will

be less than if the opening were made by nature. In some instances, a covering of collodion will prove useful.

Anthrax, or Carbuncle.—The latter of the before-mentioned boils is sometimes designated a carbuncle: that is, when the blood is in a state of low vitality; and when the boil is more or less flat, and involving a considerable area of cellular tissue, the term is not so inappropriate. By the term carbuncle is commonly understood a broad, flat tumor, with a doughy feel and a livid color. The cellular tissue is primarily affected, in which a deposit of imperfect lymph takes place, with coloring matter of the blood —perhaps blood itself. This causes a distinct and somewhat even elevation of the superjacent integument.

Causes.—The causes may be given as *local* and *general*, the latter of which are nearly the same as in the last-mentioned kind of boil. The vitiated state of the blood is the principal cause of the local affection. The *local* cause may be simply a weakness in the part—a want of tone in the vessels; or it may be from a blow upon the part, or some irritation. Whatever the cause, there will be found venous congestion of the cellular tissue; then an imperfect kind of fibrin effused; and then the blood becomes stagnant in the part, and the characteristics of the anthrax are developed. The tumor is formed slowly. The amount of fibrin effused is not great, and it possesses a low degree of vitality. When it degenerates into pus, it is found in small drops, scattered through the mass of stagnant blood and the sloughing tissue. Although the disease commences in the subcutaneous tissue, the integument is soon compromised. The whole action, thereafter, seems to be a slow and imperfect *attempt to detach the substance* which has become a foreign body. Some portions of the tissue may slough away; here and there, it may be really gangrenous. In the neighborhood of the mass, perhaps even at the line which marks its circumference, a more healthy action may be manifested; but the blood being in a weak or ill-conditioned state, repair is impossible; and while repair fails, the blood is further poisoned by the sloughing mass. As the action is asthenic—slow in its onset, slow in its course—the pain is never acute, but sometimes, although dull, is very distressing. The constitution, at the commencement at fault, shows, as the disease continues, increasing vitiation, and sometimes the prostration is attended with typhoid

symptoms. The disease occurs more frequently in middle life, but equally among high and low.

Treatment.—With the blood in such a condition, and the part in such a state, what can be done? Evidently it is of primary importance to improve the state of the blood, and to do so will be the first aim of the surgeon. Unless the blood can supply healthy reparative material, separation of the diseased mass cannot take place, nor can restoration follow. The general treatment must, in the main, precede any local treatment. Indeed, judging from personal observation, I think that local treatment should be avoided until the blood is in a more healthy state, as any attempt to dispel may result in the formation of a carbuncle elsewhere; and I have a distinct recollection of one case where fatal erysipelas followed purely local treatment of a comparatively small carbuncle on the temple. The great desire should be, to have established a healthy inflammatory action around the diseased mass, by which it shall be cast off. Until this is secured, I have found poulticing, as well as most other local applications, productive of mischief. But when the healthy action is established, the carbuncle will often get well itself. Generally, however, the work can be hastened by surgical aid.

The *general treatment* consists in the exhibition of tincture of iron, and other tonics; generous and stimulating diet, such as is easy of digestion. The local treatment, afterwards, will be to make a free incision through the mass, so that the fluid within it may escape to some extent. A small cut will be of little or no use; the grumous fluid, with the drops of pus, is contained in cells, and cannot easily escape: hence the necessity of making a free division of the diseased mass. A crucial incision should be made, the knife being carried completely from one side to the other in the making of both incisions, and care should be taken to divide to the very *base* of the anthrax. If this be not done, the fluid cannot find exit. If however, the subjacent fascia be well divided, then there will follow a degree of contraction of the several parts, whereby the wounds are drawn apart, and by which the fluid will be squeezed out. If poultices are ever of use, it will be after the bistoury has been used. Styptics are sometimes beneficial. I have known the application of pure turpentine to have a salutary effect in facilitating the separation of the slough.

Chilblains.—This variety of inflammation is exceedingly disagreeable, although not dangerous to the patient. It is characterized by a most distressing itching pain. The feet are more commonly attacked. The *cause* seems to be a frequent or continued exposure of the part to a *wet cold*, and an occasional sudden change in the temperature from the cold to a heated state. The disease may often be witnessed in Canada in winter, coming on in the following manner: The individual will have been wearing leaky boots, or those with very thin soles. On going into the snow, the feet will soon become thoroughly wet, and then cold. From time to time it will be necessary to warm the feet, which will be done in the most expeditious manner; the feet are thrust into the oven of a heated cooking stove, or otherwise brought into close contact with the fire. The consequence is, the boots, socks, and feet are rapidly heated before they can possibly dry, and the feet, although warm, are in a steaming bath. Relieved of the cold feet, the individual resumes his occupation in the snow. Again the feet become cold; and perhaps several times during a day, the feet will be made to undergo these widely diverse changes in temperature. For days or weeks the feet may be thus more or less exposed, until the disease is established. It is at night, when the feet are made bare and dry, that the intolerable itching pain comes on, and which, in many cases, becomes almost agonizing. It can be readily understood that the repeated and sudden changes of temperature in the feet while in a moist state, will materially affect the tissue and vessels. The blood is at one time stayed from entering; at another, it is induced to rush in with unnatural force, only to be again suddenly stopped by a renewal of the cold. Under such circumstances, physiological action can scarcely be expected to go on; instead of this, a pathological condition is induced. The disease will be more quickly established when the part is wanting in natural strength, or the blood in vitality. In some individuals there is not so free a supply of bloodvessels to the feet as in others. Such persons are subject to cold feet, and will suffer more quickly from chilblains.

The disease seems to be confined solely to the integument. As before said, it is when the part is dry, at night, and when the blood is circulating through the skin, perhaps with too much freedom. The nerves, so frequently exposed to extreme changes, are

now in a pathological state, and incapable of natural function; hence the characteristic itching pain. The cutaneous nerves are irritated, but not to such a degree or in such a way as to lead to inflammation. There is generally some redness, but not so great as in inflammation; yet sometimes the irritation is sufficient to create inflammatory action, when the redness will be correspondingly great. As a general thing, it may be said, the symptoms indicate physiological rather than pathological action.

Treatment.—Obviously the first thing is to remove the cause. Having an understanding as to what leads to the disease, precaution must be taken to prevent the first causes; and, these being removed, nature will often be quite able to restore, and that speedily. But the surgeon may be called upon to treat the torturing pain. To do this the application of a coating or sedative lotion will be found serviceable. A lotion of lead and laudanum I have found serviceable. Warm applications are almost always *otherwise* than beneficial. *Cold*, on the contrary, is generally grateful. Another lotion which I can recommend is of tincture of iron and belladonna.

Frostbites.—The abstraction of heat from the part exposed may be so great as to entirely destroy the vitality of the tissue, and arrest therein the circulation of blood, consequently causing gangrene. On the other hand, the part may be but slightly affected; and then every condition between the two will naturally be met with. In some cases there will be but a trace of vitality in the affected part; in others there will be only a slight disturbance of the natural vitality. But it is not by the immediate effects of cold that destruction alone takes place. When the cold has been intense, although not sufficient to destroy, there is often a reaction so great as to overcome the weakened tissues. The temperature of the part is suddenly increased, and the blood rushes into the part. The vessels are unable to resist the pressure made upon them, and are overcome, so that stagnation of blood ensues, and the whole structure is doomed to destruction. In these two ways the cold may cause death of the tissue, directly and indirectly.

The parts more ordinarily frozen are the feet, hands, ears, or some part of the face; and, consequently, aside from the destruction of tissue, there is the important consideration of deformity.

It therefore behooves the surgeon to endeavor to limit the extent of disease—the degree of gangrene; because, when the tissue perishes, it is the same as in any other kind of gangrene, and will require the same treatment. It is only while the tissue is yet in a frozen state that hopes may exist of averting or limiting destruction; and it is of the treatment while in that state I have now to speak.

Treatment.—The surgeon should remember, when called upon to treat a frozen limb (but he will more frequently be called after reaction has taken place), that the temperature must be very gradually raised, the circulation gradually restored in the frosted structure. *The restoration of temperature must be from within; the heat must come from the individual by the blood slowly creeping into the vessels of the part.* A more certain way of destroying the tissue cannot be followed than to cause thawing on the surface before it has taken place in the deeper part. Although the frost is removed, blood cannot enter. Infiltration of serum ensues, and moist gangrene is the result. Friction, so often practised by the ignorant, will only increase the danger. Rubbing a part will be sufficient often to *prevent* the freezing, and is an excellent method of restoring the circulation when it has begun to flag under the depressing influence of cold; but when a part is actually frozen it should never be adopted, as the conditions are widely different.

In order to fulfil the indications above specified, the patient must be placed in a comparatively cool room, while snow or some refrigerating application is used to the frozen part. The application of cold is in reality to prevent the external part from thawing until the deeper has been restored. When the neighboring tissue increases in temperature it will be known that the deeper portion is being entered by the blood; and, as the lower stratum is gradually restored, the external application will be increased in temperature. If snow is available, it will be preferable to anything else; but, I repeat, that the part *must never be rubbed*, not even with snow. When the circulation is fully and safely restored, strict rest and attention to position must be observed. In severe cases there is great danger of subsequent inflammation. The tone of the capillaries has been seriously impaired; while the blood, uncontrolled, rushes into the part, and, overcoming the little remaining power to contract, soon leads to transudation of lymph.

The congestion may be active or passive, and will be attended with corresponding results. Sometimes, as before observed, the sudden inrush of blood, when reaction is consummated, will soon terminate in the death of more or less of the affected structure. Frequently it will be a matter of doubt as to how much will recover and how much perish. In such cases the same course of treatment will be pursued toward the part as if certain of its recovery. When a portion has perished, the treatment for gangrene will be adopted.

Burns may be occasioned by some hard substance, as a metal, or a burning coal, or by hot water or other fluids. The burn may actually destroy the tissue, or only affect or derange its vitality. Often one part will be destroyed, and another part only deranged or partially destroyed. A peculiarity of burns, always present, is the exalted sensibility of the nerves which are affected, if not entirely destroyed. When the skin is detached, so as to expose the nerves to the air, the pain is most acute and torturing. In all kinds of burns this sensitiveness is present, and constitutes the most prominent symptom. It is not the pain of inflammation; it seems to be solely due to exaltation of nervous function. The explanation is not easy. Conjectures may be ventured, but investigation has not fully solved the problem. It may be that the great and sudden heat so changes the elements of the nerve-tissue that it is incapacitated for the natural function; or, perhaps, the heat acts chemically upon one or more elements of the tissue, whereby its electrical condition is disturbed. The great *practical* fact, however, for the surgeon is, that the contact of air induces extreme pain, and one which indicates an important part of the treatment.

Causes and Division.—When the burn is made by a hard substance, more or less of the part will be charred. When a fluid is the substance which has acted, the skin will be at once deprived of its vitality; but it may remain intact, unbroken. Beneath serum will rapidly be poured out, and also liquor sanguinis. Here, then, is a general division into two kinds. Another and a convenient division is generally given, based upon the degree of depth to which the structure is involved. 1st. Where the skin alone is burned, but not destroyed. 2d. Where the skin is quite destroyed. 3d. Where the subcutaneous structures are extensively involved.

Prognosis.—Burns are generally attended with a great constitutional shock, which in children is very often fatal. The degree of shock, and therefore danger, depends more upon the extent of integumental surface involved than the depth to which the burn extends. Burns are exceedingly fatal to children, more especially when upon the thorax and abdomen. Although at first there may be little or no constitutional prostration, yet it is likely to present itself after a week or ten days. Sometimes inflammation of the bowels arises from sympathy and causes death. In every case of extensive burns in children the *prognosis* must be doubtful.

Treatment has already been indicated. The great pain has a profound effect upon the system, and may lead to exhausting inflammation. The healing process is slow; the lymph of the liquor sanguinis does not, for some reason, undergo that development natural to the healing process. The supply is too great, and its vitality is too high; it does not quickly coagulate, and therefore flows away with the serum. This continued discharge will soon exhaust the strength of the patient. The overactive nerves of the skin are excited by exposure to air; they should therefore be protected, if possible, and at once.

In cases of scald the greatest care must be taken to preserve the natural covering, although dead. Often, unfortunately, this will have been sacrificed in removing the clothing. If the surgeon be present in time, let the garment of cloth or boot be *cut* off with care. When the cuticle is gone, the covering substituted must be something that will not increase the irritation of the nerves. To meet this requirement many things have been recommended. A common and a domestic agent is *wheaten flour*. I have found its effects the most happy in a large number of cases; it requires to be applied freely. The gluten of the flour uniting with the fibrin forms an impervious coating. I cannot conceive a worse procedure than for the surgeon, having been called to attend, and finding the part covered with flour, and perhaps cotton-wool, to remove that covering, in order to see the nature of the burn—to *do something*. Even were he to renew the application, the temporary exposure may have turned an evenly balanced scale against the life of the patient. If, however, the pain continue, the surgeon should examine the part, not perhaps to remove what has been applied, but to increase its efficiency. I repeat, I have used

flour so often, and with such complete success, that I never think of using anything else, unless it first fail; and I do not remember to have seen any other application control the pain when it did not. In every case, if the surgeon finds the burned surface *covered with anything* and the pain has ceased, he should by all means leave the covering alone. There are other applications deserving of notice, such as a thorough clothing of cotton-wool, linseed oil, and lime-water in equal parts. But, perhaps, the one of most importance to be used after some hours, when the nerves are very sensitive, is turpentine in the form of an ointment. I have seen it afford decided and grateful relief. Sedatives may be useful, but turpentine seems to enjoy a peculiar advantage, to possess a specific property in allaying the pain. It is the concurrent testimony of many. Its mode of action, however, is unknown. The opinion may be hazarded that it restores the equilibrium in the elements of the nerves, and so diminishes their undue sensibility. However this may be, it promptly gives comfort and promotes restoration. When a portion is actually destroyed, made gangrenous, it will have to be separated in the ordinary way. While this is being done by nature, the surgeon must endeavor to control the tendency to extreme action. During the process of detachment, as well as while healing is taking place, the nerves retain their extraordinary sensitiveness.

In scalds there is, generally, a rapid collection of serum under the cuticle. While it is so necessary to preserve the cuticle, it is equally so to make a way of escape for this fluid, because its presence increases the pain. To let it out, small punctures must be made from time to time. The danger of constitutional prostration must be remembered, and, as far as possible, averted, by the exhibition of good diet and suitable stimulants. As healing slowly progresses, and is finally consummated, there is exhibited a great tendency to contraction; and, when the cicatrix is fully formed, there may result considerable deformity. The fibrin is slow to coagulate and form granulations, because of its high vitality; but when it does take on that action it contracts with great firmness.

The next two varieties of inflammation in our category are *hemorrhagic* and *scorbutic*. As these belong exclusively to the practice of medicine, they will not be considered in this work.

CHAPTER XVI.

Scrofulous Inflammation—Causes; Tubercle—Scrofula—Terminations—Treatment.

Of this variety, very much might be said. But it does not come within the province of this work to consider the disease of scrofula in detail—to fully discuss its pathology and consider its treatment. It, as well as the two referred to in the last chapter, is a disease pertaining to medicine; yet it very frequently comes under the notice of the surgeon, either as cause or effect of surgical complaint. A disease of such general prevalence, and with tendencies so fatal, involving in many cases the life and happiness of families, cannot but command the attention of both surgeon and physician. It is therefore deemed expedient to devote a short space to the subject.

Often will the surgeon be consulted with respect to an abscess located in the neck, generally just below the chin, and at one side. Upon inquiry, it will be learned that at the first there was a small lump; small and painless generally, but at times causing a little uneasiness. Liniments and numerous other applications, very likely the tincture of iodine, had been frequently used, with only the effect of making it increase in size and soreness. After a time, perhaps several months, symptoms of inflammation presented themselves in the part, and at last the tumor was found to have been converted into a chronic abscess. An opening being made, the contents were seen to consist of a thin, curdy pus, with perhaps solid particles, and also the *debris* of the ulcerated tissue intermixed. In the neighborhood of the abscess will often be discovered other small lumps, like the original one; some small, some larger, perhaps some beginning to soften. Now, these hard bodies are lymphatic glands in which something has been deposited, and in so large a quantity as to impair the function of the gland, and at last to destroy it. It is this deposit which has caused the inflammation of the gland, and the abscess, and then the ulceration or sloughing of the gland; hence the peculiar character of the

contents of the abscess. The question arises: What was this material which had been deposited in the gland? What the source? What is its nature? To consider these questions fully, and adduce all that might be advanced respecting them, is quite beyond my present purpose. Suffice it to say, that this deposit is of a fibrinous nature, and its source must be the blood. We have before learned that fibrin may be possessed of too much vitality, or it may be wanting in natural vitality. It may be prone to degenerate, or be liable to sudden death, even while within the living body.

It would seem that in scrofula the fibrin of the blood is devoid of vitality, and under certain circumstances will separate from the blood and be deposited in one or more of the various tissues, but showing a preference for certain ones—at least it is found more frequently deposited in them. I have said that the source of this morbid material is the blood; but it may be asked, how comes it that the lymph-glands become the abode of the deposit? It is true, the glands discharge a peculiar duty apart from the circulation of the blood; but it must be remembered that there is fibrin in the lymphatic vessels, which courses along through the lymphatic system to mingle with the blood. And it would seem as if the glands, standing as sentinels to protect the blood, strive to arrest the morbid material as it seeks to enter the mass of blood, and by so doing become the seat of deposit.

The glands in every part of the body are susceptible, as they are exposed. It is in the young that deposit in the glands most frequently takes place. It occupies the interstices of the tissue, and so constitutes what is understood to be *scrofula*. At a more advanced period of life, the deposit is found in other as well as the glandular system, and shows itself in a more perceptible state, being in the form of *tubercles*, thus constituting what is called *tuberculosis*. Scrofula and tuberculosis, then, are the same disease: only that the former is incident to childhood, and is characterized by infiltration of the matter in the interstices; while the latter is more common to adult age, and is known by the existence of the matter in appreciable quantities, forming the tubercle. In every case, the separation of the fibrin from the blood takes place in a manner which may be said to be unaccountable. Possessing a low degree of vitality, as manifested by a quick coagulation and hasty death, it soon becomes, to all intents and purposes, a foreign

body. At the best, now and then, there is but the slightest display of life in the matter. There is a total absence of blood-vessels in its substance, as well of nerves and absorbents. If you examine with the microscope a portion of the tubercular matter, the proof is conclusive that vitality is absent. There is no perfect cell, such as belongs to healthy fibrin. The broken-down walls of aborted cells may be seen; and now and then, soon after the deposit, a whole cell may be discovered, when the disease is not fully developed. But in this cell can never be seen a single sound, life-enduring nucleus; instead, there may be recognized the cell filled with granular matter, derived from the fruitless attempts to conceive offspring.

But what is this disease of the fibrin? Why is it thus disposed to separate itself from the blood to which it belongs? Why has it assumed a low standard of vitality? Why does it so quickly die when it has parted from the blood? The above questions have often been asked and answered, or attempts have been made to answer them.

The fibrin of the consumptive blood, like a species about to become extinct, is incapable of resisting anything which tests its strength. Efforts are made to display vitality, but they are generally abortive. In whatever way the fibrin of the blood is elaborated, the old race seems to have deteriorated, and is being succeeded by a race still lower in the scale of animal life. The offspring is puny and sickly, although numerous, and is incapable of discharging the duties which belong to it. The current of its usefulness is turned aside into abnormal channels, only to destroy. The deterioration of species, the gradual decline and final extermination of individual families of the human race, is a subject of interest and importance, and has engaged the attention of many scientific men. With this subject the questions under consideration are intimately connected; the solving of one problem will explain the other. As the causes which lead to the destruction of individual races may require the lifetime of generations to consummate the effect, so with consumption. It may be that it is a law of animal life that decline and death shall come to races, as to individuals, and that they shall be wrought by changes in the elements of the fabric, analogous to those which are apparent outwardly in the race itself. But he whose business it is to seek for disease and

the causes thereof, who so often finds that malady is the inevitable result of a violation of physiological laws, is disposed to seek for such causes of deterioration in the human frame, and in the non-observance of physiological laws. The belief cannot be shaken that the aggregate of human life might be lengthened, and that life might be made less painful and better fitted to discharge its high duties. We cannot believe, that, live as we may, the extinction of races must come.

Causes.—With respect to the causes of scrofula, there is reason to believe that a *want of cleanliness of the skin* is one, at least, of them. The skin may be considered an excretory organ, which throws out upon its surface effete material, that ought to be removed therefrom. But in how many instances is it allowed there to remain, the skin being unwashed for months, perhaps for years. The matter is constantly being reabsorbed, again to enter the system. We have seen that the glands are often sufferers in scrofulous disease, and may we not look upon that fact as supporting this hypothesis? Not that the effect upon the fibrin is immediate; on the contrary, it may be a long time before the disease is fully engendered, for if the other excretory organs be in an efficient condition, the fault of the skin may be in part compensated for.

A second cause which is given is the *frequent removals in the human race from one clime to another*, and the consequent *changes of diet* and *various other influences* connected therewith, which affect the life. In all ages, these changes have taken place. It is not alone the emigrant of modern days going to a new country to try his fortunes. In olden time, the invading army went forth to conquer a new territory with a climate unlike that of their native land, and the army was followed by a peopling kinsmen, who remained to live and to die in the uncongenial clime. And in recent years, the over-peopled countries of Europe have sent hither to the United States and Canada thousands after thousands to find homes and finally their graves. Not only the American continent is being possessed by Europeans, but as well colonies in every part of the globe. Thus we see, that from one cause and another the human race has ever been flitting; ever, since Adam took his sorrowing departure from the garden of Eden; and as animals in lower life may not with impunity be transferred from one country

to another, so it must likewise be with the higher animal, man. The effect of the evil might not immediately present itself; the individual who exposed himself to the climatic change might not feel the effect even during his life. It might be, the second or third generation had come before the disease were fully developed. Although man would seem, to a great extent, to be capable of adapting himself to all climes, to all conditions of life, to almost all kinds of diet, yet there is a limit to his powers of resistance and of recuperation. When two or more causes are acting simultaneously, the limit will be sooner reached. On the contrary, when many of the laws of life are not exposed to violation, the infringement of one may not bring an early punishment.

But it must not be forgotten that in not a few cases emigration seems to prolong individual life, and to render that life a more healthy one. Under certain circumstances it is undoubtedly the case; and I wish it to be distinctly understood that I have not undertaken to show that emigration is necessarily a cause of deterioration; and that the emigrant is necessarily doomed to decay, and his family in time to die out. I wish to assert quite a different thing. The causes I have attempted to explain of scrofula, due to emigration, I trust act not on all; nay, I am sure they do not; perhaps only on a minority. I find in the London "Lancet," of February, 1858, the following startling statements from the able editor: "In spite of some fashionable theories of the day, we are disposed to agree with that school of anthropology which maintains that the races of men can permanently maintain themselves and thrive in those countries alone to which they originally belong. To point to quarters of the globe at present peopled by races foreign to the land, and apparently flourishing commercially as facts opposed to our doctrine, would be met by the reply, that annually into these countries have been and still are imported thousands upon thousands of emigrants, representing the best blood of the colonizing stock. That to form any satisfactory conclusion this constant replenishment must be arrested, and a sufficient length of time allowed to elapse to enable to see how the foreign race could propagate and maintain itself in its adopted clime. We believe it would fail, and gradually vanish and die out." (!)

It would be an unpleasant thing to contemplate that our children were destined to extermination unless they returned to the land

of their forefathers. Against any such strong assertions I would enter my humble protest. The editor of the "Lancet," as well as other Englishmen, in casting their eyes across the Atlantic upon the North American continent, have been unable to see aught but a mighty republic. The inhabitants of British America have always sunk into insignificance, been quite hidden by their frontier neighbors. I make this remark to add that in Canada are to be seen quite remote descendants of two of the most prominent people of Europe, the British and French, and, I am prepared to assert, with no marked signs of physical degeneration. The French of Lower Canada, even under many adverse circumstances, have fully retained their ancient bodily vigor, and can compare favorably with the present inhabitants of old France, while their number has increased. Yet their ancestors, many of them, emigrated to New France two hundred years ago; and, since the colony became a part of Britain, no "replenishment" has been received from the old stock.

Turning to Upper Canada we find a fact no less important and quite as antagonistic to the theory that native Americans are doomed to die out.

In consequence of the American Revolutionary war, some twenty-five or thirty thousand United Empire Loyalists were forced or induced to seek a home in the Canadian wilderness. Many of these were descendants of those who had first peopled New Holland along the banks of the Hudson. A large number of these United Empire Loyalists settled along the St. Lawrence and the Bay of Quinte. In the main, indeed, almost altogether, until very recently, these old settlers have intermarried. Now and then an emigrant might settle among them, but it was an exception. The great-grandchildren of those American pioneers now live on the old homestead, and are found scattered over the whole province. And although I have no positive data upon which to base my assertion, yet, from careful observation, I have no hesitation in declaring that in physical development, in slight mortality among the children, in length of life, in powers of endurance, not to say in bravery and patriotism, they cannot be excelled by any class of emigrants.

I have deemed it necessary to make these, in some respects, irrelevant remarks, lest the view I have ventured to express that

emigration is one of the causes of the scrofulous disease, might seem to corroborate the theory advanced by the editor of the "Lancet." Emigration is one of the causes, perhaps not so much because of emigration as in consequence of the emigrant not being able to adapt himself in diet and in other respects to the new climate.

So much with regard to the primary causes of scrofula; two or more of which may operate together. Whatever the causes, however, when the disease is once engendered, it does not stop with the individual, but is transmitted down to his children's children.

As surgeons we may have only to treat the local manifestations of the constitutional disease; yet it were well to understand what are the measures most likely to afford constitutional relief. The following, perhaps, are the most important remedial measures to which attention ought to be paid: 1st. Good, easily digested food. 2d. Daily ablution of the whole body, always avoiding the slightest chill. 3d. Keep the organs of digestion and excretion in a healthy and efficient condition. If these few, but essential points, were attended to, not only might the individual never be actually attacked with disease, but perhaps his children might also enjoy the same immunity, although neglecting these rules. Perhaps it is not saying too much to express the thought that, if due attention were thus paid to these physiological laws, the disease might in time be eradicated from the human race.

Two general ways have been given in which the local disease may become established. 1st. It may be diffused through the tissue. 2dly. It may be in the form of tubercle. There are several forms of tubercle. It may be like a millet seed in size, scattered through an organ (*miliary*); or it may be in much larger bodies. Again, it may be, although in bodies, *infiltrated*. Then the tubercle, whatever its form or size, may be either *gray* or *yellow*. The tubercular matter may have been yellow from the first, or it may have been gray at first, and subsequently have become yellow. The only difference between them is, that in the yellow there is a quantity of fatty matter. It is the more common opinion among pathologists that the tubercular matter is at first gray, and that it subsequently becomes impregnated with the oil globules. Again, there is the encysted tubercle, which arises from the matter gradually as it collects pressing the surrounding tissue to-

gether, and thus forming a cyst. Still another way in which the matter is found to collect is in layers, one deposit after another taking place. This is the *lamellated tubercle.*

The form of the tubercle will to a certain extent depend upon the nature of the tissue in which it is effused, the closeness of the texture, and the readiness with which it yields to pressure.

But why this effusion or deposit of tubercular matter? Why, instead of natural nutrition, is there this unnatural transudation? Why does the fibrin thus separate from the blood to become a foreign body? The diathesis existing, one of two causes may act; or they may act together to produce the deposit. First, any tissue, naturally weak, may have bloodvessels so weak, so destitute of tone, that the blood cannot circulate therein in a normal manner. It will move in a sluggish manner; and the coats of the vessels being lax, the diseased fibrin will the more readily transude, the more quickly coagulate and die. In the second place, any irritation or injury to a part, or, what is understood by catching of cold, a sudden morbid impression by which the blood is arrested in its course, may lead to the same effusion. When deposit has taken place in a part, it, acting as a foreign body, is itself a constant source of irritation, which will tend to cause still further effusion.

Terminations.—Nature will endeavor to remove this deposit, as she does every other foreign body. They may, if the deposits are not large, be removed by absorption; yet such a result, after deposit of true tubercular matter, is very rare. Sometimes the deposit parts with its more fluid portion and dries up; it will then become calcareous, and finally be surrounded by a cyst. In such a state it may not cause any irritation; but in the larger number of cases it eventuates in softening, not only of its own substance, but also of the surrounding tissue. When softening has taken place, it will constitute one form of abscess, and will thereafter follow the ordinary course; which will depend not a little on the tissue involved, as well as the extent to which the deposit had been made.

In those cases which come more especially under the notice of the surgeon a favorable issue is more likely than when they are medical cases. But even when the deposit has been made in the lungs, a cure by the efforts of nature is not so rare as is commonly

supposed. Three ways are given by Bennet, in which the disease, when in the lung, may be turned toward a cure. "1. By the gradual transformation of the exudation into cretaceous and calcareous concretions. 2. By expectoration and absorption of the exudation, the collapse of the ulcerated walls, and formation of a cicatrix. 3. By the ulcerated walls becoming covered with a smooth membrane, remaining open, and constituting chronic cavities, which have occasionally been mistaken for dilated bronchi." And further, "that one or all of these modes of arrestment may be detected in the same lung." But too often the extent of disease precludes the possibility of either of such favorable terminations.

The *local treatment* of those cases which are surgical will depend upon the stage at which the surgeon is called. Hopes may be entertained of its dissipation, if it be not too large, or of long standing. When an abscess has resulted, it will receive the ordinary local treatment. If a lymphatic gland be involved hopelessly, it has been recommended to allow the abscess to remain unopened, not in the attempt to procure absorption of the contents, but to secure entire destruction of the gland by the inflammatory process, which otherwise would remain a long time before it could be expelled by ulceration and sloughing. As a general thing, however, the abscess ought to be opened early. The tissue to be expelled may, if necessary, be got rid of by caustic, which is by some strongly recommended. The constitutional treatment will precede, in most cases, as well as accompany, the local.

CHAPTER XVII.

Gonorrhœal Inflammation.

The *gouty*, the *rheumatic*, and the *diphtheritic* varieties of inflammation will also be omitted in this work; so that I now come to the *gonorrhœal inflammation.*

It will be remembered that inflammation may be divided into *specific* and *non-specific.* Gonorrhœa is one of the specific forms, being due to a specific cause. The poison is created by *prostitu-*

tion. The excessive, irregular, and unnatural irritation due to lawless sexual intercourse begets a diseased condition of the mucous glands of the vagina, and in consequence there is secreted an abnormal fluid, which is highly irritating, and which in time will cause inflammation of the mucous membrane of the part. The pus resulting from this inflammation is capable, when brought in contact with a healthy mucous membrane, of causing a similar inflammation; hence its specific nature. Commonly, gonorrhœa is confined to the mucous membrane of the genital organs, but in the female it may extend to the rectum. The eye sometimes becomes affected. It may be conveyed to that organ by the hand, or by a towel, and, according to some authority, by the air, the pus-cells becoming dry, and then while floating in the air are carried to that organ. Inflammation, of the urethra in the male and vagina in the female, may arise from other causes, and in most respects the symptoms be the same; therefore, by simply looking at a case of inflammation (urethritis), the surgeon cannot be sure as to the nature of the cause. There will, however, generally be other circumstances connected with the case, from which correct conclusions may be drawn.

Inflammation of the male urethra may be produced by an injury; by riding on horseback; also from sexual connection when there are other discharges from the vagina than the gonorrhœal. Sexual intercourse during menstruation may produce urethritis. The woman with whites, or ulcers of the vagina or of the uterus, may cause her husband to have it. I have, at the time of writing this, a clergyman under my care who has inflammation very closely resembling gonorrhœa, which is attributable to ulcers on the os uteri. Thus it will be seen, that although inflammation of the urethra may always be justly regarded with suspicion, yet other causes are quite competent to produce the disease. Further than this, true gonorrhœa may be contracted in other ways than by sexual intercourse. The virtuous may contract it, and even be ignorant as to the cause and nature of the disease. A very common way is from sitting in a water-closet, upon the seat of which the poison has been left by a previous occupant. In this way a female as well as a male may receive the disease.

The length of time requisite for incubation varies very much, from a day or two to a fortnight. Much will depend upon the

virulence and quantity of poison deposited upon the mucous surface. The resulting inflammation has well-marked symptoms, and as a general thing it is a *healthy* attempt to dispose of a poison which is obnoxious to the part. The first indication of the disease in the male is a redness of the glans penis, especially at the orifice of the urethra. The glans, and perhaps the whole penis, is a little swollen, though not in a state of erection. When the disease is fully established, and the surface of the membrane is made tender, the passing of urine causes a distressing smarting pain. Probably if it were not for this periodical contact of the urine, the disease would run a more definite and speedy course; that is, the action would continue only until the poison had been carried away in the discharge, whereupon healing would take place. But the urine feeds a flame which another cause has kindled.

Gonorrhœa, although a *venereal* disease, is strictly a *local* disorder; and although it may give rise to other serious diseases in the parts, it never involves the constitution beyond what may be due to inflammatory fever, and exhaustion from continued irritation. Besides the passing urine, there are causes of irritation, which will assist to continue the diseased action; inflammation tends to cause erection of the penis, and this will lend some assistance to other causes. Sometimes the erection of the organ is embarrassed in consequence of a spasmodic action of the engaged parts, and sometimes from the effusion of lymph external to the urethra, which will prevent a regular filling of the tissue with blood such as takes place at the time of erection. In consequence of this irregularity, the organ is often bent with the end downward, sometimes almost at a right angle. This is a cause of great distress to the patient. The inflammation commences at or near the orifice of the urethra; but it extends along the membrane, generally, an inch or two, and may even to the bladder. Probably it is at the point of termination of the affected membrane where the bending takes place. This is called *chordee*. It more frequently comes on during the night, while the patient is sleeping, and is very likely provoked by the warmth of the bed, or by lascivious dreams. But the unnatural irritation incident to the disease is a common cause of erection during the waking as well as during the sleeping moments.

The principal product of the inflammation is pus of a greenish

color and offensive nature. As before said, lymph may be effused external to the urethra, and give rise to chordee. But a more calamitous result may ensue, in the form of a stricture. The plastic material thrown out around the urethra may coagulate after a little, and at the same time contract, so as to diminish the size of the canal. This stricture may be very narrow, like a girdle; or it may be quite broad; but several attacks of inflammation will be necessary to form one so extensive. When a stricture is formed, it will be generally the effects of protracted disease, or perhaps of injudicious attempts to arrest the discharge at an early date. The degree of constriction varies; it may be but slight, or it may almost close the channel. Although at first very little, if the irritation continue, the lymph will also continue to be effused and to be organized, by which the stricture will encroach more and more upon the urethra. Sometimes, indeed, the passage may become so far closed that the passage of urine is impossible, when the most disastrous results will follow.

A not uncommon complication of the inflammation is metastasis to the testicles. I have repeatedly seen orchitis produced by strong injections into the urethra at the commencement of the disease, by which the discharge was suddenly stopped. But it may arise purely from sympathy.

Treatment of Gonorrhœa.—The indications for the treatment of gonorrhœa will be quickly comprehended if the cause of the disease is considered aright, and as well the *cause* of the *continuance* of the inflammation. No attempt should be made to abort the disease. Not only may orchitis be the result of such attempt, but the inflammation may thereby be increased. It may, perhaps, be arrested for a little; but generally it will break out with increased violence. It is possible to destroy the poison, and *prevent* inflammation, by injection, if it be used *before the disease is fully established;* but the surgeon is not likely to be consulted before that, and if he were, it would in most cases be impossible to diagnosticate the coming disease. In suspicious cases, an injection of some mild material might be given as a precaution. The disease fully established, it must rather be controlled than stopped. Indeed, there is a certain amount of poison which must be thrown off in the discharge; and as long as the discharge continues to be thick, and of a greenish yellow, there is most likely poison there,

and consequently the disease may be imparted to another person. This poison disposed of, it may be taken for granted that the discharge would cease, were it not for the acid urine which in passing creates so much pain.

The chief thing, then, to which the attention of the surgeon must be directed at first, is the administration of such medicines as will render the urine less irritating, and the enjoining of those rules as to diet and drink which will tend to the same end. To neutralize the acid condition of the urine, alkalies must be administered. Stimulating diet and drink should be most steadily avoided, and bland food and drink exclusively adhered to. Meat must be abstained from as a general thing, at first, and farinaceous food used instead. As a drink, nothing can be more useful than flaxseed tea, to be taken as often as may be done. To fulfil the above indications as to medicines, I have been in the habit of using the following prescription. It is one which I had the opportunity of testing and seeing tested, during a period of fourteen months, while House Surgeon to the Seaman's Retreat, New York, where there were a large number of cases constantly in hospital. I have no hesitation in giving it a strong recommendation: ℞. Bal. Cop. ℥viij; Spts. Etheris Nit. ℥vi; Tinc. Opii Camph. ℥ij; Liquor Pot. ℥j. M. ft. mist. A tablespoonful to be taken three times a day.

But I would not recommend the exhibition of this during the first stage of very active inflammation. Copaiba, and also cubebs, are more beneficial after the more active symptoms have subsided, and when the discharge has lost the peculiar thick greenish appearance. These medicines are somewhat stimulating, and have a particular affinity to the urinary organs; and it is when the discharge is beginning to be chronic, the membrane being in a morbid state, that copaiba particularly is found to be promptly beneficial. During the first stage the disease should be treated antiphlogistically. Injections will, under proper circumstances, prove serviceable. At first they should be astringent; subsequently they may also be useful. Sulphate of zinc is a useful medicine for injection, and so is the nitrate of silver. The latter may be used at ten grains to the ounce, being employed only once; or it may be more safely used at two or three grains to the ounce. The strong solution has been recommended to cut short the disease, but I cannot

advise its use. The milder solution is often serviceable when the discharge is maintained by the acid urine. The raw surface is by it supplied with a coating, and thereby protection is afforded. The disease very often degenerates into a chronic discharge—*gleet*, which may continue for a long time, with occasional exacerbations. There may be but little pain attending gleet even when voiding urine. The discharge is thinner and much lighter in color. Of course the patient is anxious to be rid of it as he was of the disease at first. At this time it is doubtful whether the discharge possesses the power to cause disease in another when brought in contact with a mucous surface. If the medicine in the above given prescription fails, and the discharge is in the form of gleet, the tincture of iron may be tried with a fair prospect of being useful. Diligent inquiry ought to be made as to whether any special exciting cause is allowed to operate, such as venery, or lascivious thoughts, &c. The painful chordee may sometimes be allayed or arrested by taking a few grains of camphor at night. There are other general principles concerned in the treatment, of which no special instruction need here be given.

CHAPTER XVIII.

Syphilitic Inflammation—Pathology—Question of Duality—Hard Chancre—Its Treatment—Soft Chancre—Its Treatment—Buboes—Treatment of Buboes—Constitutional Treatment of Syphilis.

Syphilis is a specific disease, which is at once prevalent among mankind and a disgrace to humanity. It is a venereal disease, resulting from excessive or indiscriminating sexual intercourse. It is one of the scourges made by the gods from a pleasant vice. It is not my intention to investigate the question as to the way in which this disease originated, nor the time at which it became a fully developed disease. It is sufficient for our purpose to know that the disease was the result of illegitimate sexual commerce. It is a matter of more importance to understand the probable or certain way by which the malady is perpetuated. For, when it is

met with, it is a foregone conclusion that it has been contracted from another person,—that it has not been recently generated and developed. Gonorrhœa may be generated at any time under certain circumstances; but syphilis is supposed to be a disease of ancient birth, which has been transmitted down from generation to generation; perpetuated by sexual contact in most cases, nourished by vice and unrestrained passion. It may naturally be supposed that nature would be ever making her efforts to eliminate the disease from the system; but, notwithstanding such efforts, constant prostitution, with the accompaniments of filth, imperfect food, and strong drink, suffice to keep the disease in living vigor, so that it is handed down none the less virulent by the vitiated and polluted. They constitute the vehicle of this fearful and disgusting poison as it passes along from age to age, and from one generation to another.

The disease, as already intimated, is generally communicated at the time of sexual intercourse from one to the other. But it may be communicated by other means; and this is an important fact, one which may involve the life-interest and happiness of a whole family. It would seem, from recorded facts given to us by recent as well as by older writers, that the syphilitic disease may be communicated, not only by contact of the sexual parts, but also when the pus from a suppurating chancre is placed in contact by other means with the mucous membrane, or the skin from which cuticle has been removed, as for instance by the hand or by the clothes.

There is a school of French syphilographers who hold that this is the only way by which the syphilitic disease can be communicated,—that the pus from a suppurating chancre, the primary sore, is the only vehicle of the poison. M. Ricord says, "I have for many years had a number of nurses at the Hôpital du Midi; and I have often given them children to suckle who were sent to me from the Maternité with secondary affections. Never, as far as my observation extended, were these nurses infected.

"On the other hand, nurses clearly affected with secondary disease have been able to suckle infants, which were sent as being affected with syphilis (but who only had had some simple eruptions of eczema, impetigo, or porrigo), and never were these children, whilst under my inspection, infected."

On the other hand, there are a large number of writers, including many of the leading observers, on this disease, in France, Germany, England, and America, who maintain that while the disease is by far the most frequently communicated through the pus derived from a primary sore, yet it may under certain circumstances be imparted by one with *secondary* sores or eruptions. But in such cases, the disease resulting is the same as the secondary to which it owes its parentage; in every case, like begets like. (Dr. Waller.) According to others, secondary sores may produce the primary chancre after long incubation.

Venereal sores, or *chancres*, are by some divided into *syphilitic* and *non-syphilitic;* that is, into those which will infect the constitution, and those which are simply local and which possess no power to poison the system—at least no power to enter therein. It is only those which give rise to constitutional symptoms that they designate true syphilitic sores, notwithstanding the non-syphilitic are contracted in the same way, and are due to the same cause.

But the question of *duality* in syphilitic poison is yet unsettled; that is, whether the chancre which is followed by constitutional disease is a distinct affection from the one which does not produce syphilization.

Before proceeding to discuss this question, it is well to remark that the genitals, which of course are the usual seat of the primary sore, though they may be found on other parts of the body (I have seen them on the lips of sailors), may have sores upon them due to other causes, as excoriations from intercourse with one affected by non-specific ulcers of the vagina or uterus.

But an individual has been exposed to *venereal* sores; these, or the pus thereof, have come in contact with the healthy body; a day or two thereafter, or perhaps a week, a sore begins to form, often at first a vesicle. There is inflammation, and speedy ulceration. The length of time necessary for inoculation will depend upon the virulence of the poison, and the susceptibility of the part to become diseased. The extent of the sore will depend upon the same causes. The ulcers thus formed are divided into two kinds,—the hard chancre and the soft chancre. The former is followed by syphilization; the other is not.

The hard chancre, as its name implies, is characterized by well-marked induration. It is generally a small ulcer, with hard, elevated edges, cartilaginous in appearance and consistence, having a grayish color. It may be so small as to escape notice, and hence it is that now and then syphilization takes place without the individual having been aware of the primary disease. There is little or no discharge from the sore, which at the same time manifests little or no disposition to heal. In fact, the poison, constituting a peculiar irritation, has produced what is called adhesive inflammation of the most decided kind; the lymph effused, which ought to act a part in ejecting the poison and in repairing, takes on an intense action, and in coagulating acquires the cartilaginous condition.

Now, it is a question of great practical importance whether the hard (also called the Hunterian) chancre is an indication of constitutional disease. It has long been thought, by some investigators and thinkers upon the pathology of syphilis, that the formation of the hard chancre is a salutary operation of nature, by which the poison is, so to speak, locked up in the part, and thereby prevented from entering the system. The poison, being applied to the part, creates inflammatory action, and the resulting effusion, quick to coagulate, embraces within the mass the obnoxious elements; and although its power for evil might not be rendered thereby nugatory, yet as fast as its influence extends, so far and so quickly will the adhesive barrier be formed. But this beautiful theory cannot be said to have a solid foundation. More recent observation and investigation would seem to support another theory, antagonistic to that.

It is declared, by those who hold the later view, that the hard chancre, with its adhesive inflammation, so characteristic of the disease, is an unmistakable evidence of constitutional contamination; that the disease has already entered the system. We have seen that there are three general circumstances which may determine adhesive inflammation, or suppurative inflammation: these are, "the state of the blood," "the seat of the inflammation," "the degree of inflammation." Now, it matters not whether the cause be one or the other, or even if two are acting together; there must always be a space of time between the cause and the effect. And it can hardly be otherwise than that, while the poison

is acting to cause adhesive inflammation, it is also penetrating to the adjacent tissue; so that, although a barrier of hard fibrin is formed, it is too late to close all the avenues to the system; it is, in reality, closing the door after the beast has been stolen. Thus we see that adhesive inflammation cannot prevent syphilization; that before the hard chancre has had time to form, the poison has passed beyond the power of any restriction it might place to it, although it may not yet have actually found its way into the system.

But we will suppose that suppurative inflammation follows the application of the irritation. The lymph, instead of making attempts to develop itself, immediately degenerates into pus and escapes—is thrown off. The benefit is obvious. Not only is the lymph quickly got rid of, but likewise the poison, which would have been locked up had the inflammation been adhesive, is also ejected. More than this: when suppuration is established in a part, there is naturally a determination of blood thereto. The absorbents are not so active; perhaps are inactive. Consequently, there is a current outward instead of inward; and so far, there is a vehicle for expulsion of the poison, not only of that which may have been upon the surface, but also of that which may have entered to the neighboring tissue.

In the latter kind of inflammation, which is attended with suppuration, the sore being bathed with pus, we have what is designated the *soft chancre*. This ulcer does not differ in appearance from one that has been caused by other than a specific disease. It is larger than the hard chancre; and, unlike that also, there is generally more than one. Around the primary sore there are likely to form, after a while, several more. The sore is well-defined at its borders, looking as if it had been cut out; this is the only peculiar mark in its appearance.

Now, it is an important fact that syphilization rarely, if ever, follows as a result of the soft chancre, although it cannot be questioned that it is quite as much due to a specific disease as the hard is. From these facts it has been inferred that there are two kinds, at least, of syphilis; that one kind is characterized by a hard chancre, followed by constitutional symptoms, and the other kind by a soft chancre, which is not followed by further disease. But the correctness of these conclusions may certainly be ques-

tioned. There are three circumstances, as just above stated, which may control the changes which take place in lymph subsequent to its effusion. We have seen that after the application of the poison the inflammation may be either adhesive or suppurative. Now, it would seem that the poison so acts upon the part that the inflammatory lymph exhibits a decided tendency to coagulate, and probably this is the natural effect of the poison in every case; but in certain cases, may it not be (and I only offer it as a plausible view) that another controlling influence, adverse to the first, comes into operation, very likely arising from the state of the blood, by which the lymph is made to degenerate into pus? The conclusion which I wish to draw from the above is, that the syphilitic poison is always the same, but its effects upon the system may be modified by the state the system is in at the time the poison is brought in contact with the body. *That it naturally causes adhesive inflammation, but under certain circumstances this tendency is counteracted. That when it acts alone, and causes the hard chancre, inoculation is the result; but when from any other cause the soft chancre is produced, the poison is ejected and no syphilization ensues.* When, therefore, a Hunterian chancre is met with, it cannot be inferred that the constitution is already affected, and the hard sore is the effect of constitutional disease; but that there is imminent danger of such constitutional affection—that the poison is being held in the most suitable state to secure syphilization.

In connection with this question, it requires to be mentioned that swelling of the glands at the groin, and the formation of buboes, is more generally an attendant of the soft chancre than of the hard. This fact, although at first it may seem to oppose the view advanced, in reality supports it. It is not at all irrational to suppose that, although the venereal poison is mainly expelled by the suppurating sore, yet the lymphatic glands may be called upon to stay the entrance of a very limited portion—a duty which they faithfully perform, even at the expense of their own integrity. The poisonous material even here causes inflammation, followed by suppuration, and so the pus and poison escape together; while on the contrary, in the case of the hard chancre, the syphilitic poison has only the effect of causing induration of the glands, and thereby incapacitating them for their natural duty, so that the

system becomes contaminated. To repeat: in the case of the soft chancre, the most of the syphilitic poison is cast out by the suppurating sore, and what little may be taken up by the absorbents is arrested at the first system of glands; consequently, these glands take on a similar suppurative action, whereby is disposed of that limited portion which had so far obtained an entrance to the general system.

Treatment of the Hunterian chancre will depend, undoubtedly, on the view which may be held relative to the question just discussed. If adhesive inflammation is regarded as an indication of constitutional disease, then the local treatment will be simply directed to the healing of the indolent sore; but if, on the contrary, it is to be considered a sign of local deposit of the poison, of which a portion may or may not have been absorbed, and that the indurated lymph is holding the poison in a manner which may favor its absorption, whereas if this lymph were to degenerate into pus it would conduce to the expulsion of the poison, then the efforts of the surgeon will be to obtain an action in the part which will result in suppuration, and thus turn the current outward and secure the ejection of the morbid element.

Taking the view that in the hard and grayish substance, which constituted the chancre, there is a quantity of poison, the proper course would be to apply a caustic, so as to destroy the whole of the substance, and thereby much of the poison itself. Nitric acid, or nitrate of silver, will do the work effectually. It may be necessary to apply the caustic a second time; and it should be repeated until the characteristic hardness is no more observed. The caustic application will have the effect of producing suppuration as well, and so far conduce to the required end. But if the constitution has become affected, if the poison has already produced syphilization, the indurated condition may be expected to continue, notwithstanding any local treatment. In such cases it will often be found necessary to exhibit such medicines as will change the nature of the fibrin upon the chancre. To do this the most effectual drug is mercury; yet this medicine cannot be thus referred to without the accompanying remark, that its administration is attended with danger, and may be the cause of serious complications. This will hereafter be particularly referred to. But in those cases where the constitution is not involved, mercury is *contra-indicated*, irre-

spective of the evils likely to follow its use. It will in reality favor syphilization by softening the hardened substance of the chancre, and thereby setting the poison free, to be taken up by the absorbents. To repeat, then, the treatment of the hard chancre will in the first place be directed to the sore alone. Caustic applications will be made to it with the view of destroying the coagulated and indurated fibrin, and at the same time the poison which may remain in the part. If the one application does not change the character of the sore the caustic must be repeated, until either the sore is altered in appearance or it becomes certain that the constitution is already involved. When the fact is established that the peculiar hard sore is due to constitutional poison, and not simply to the localized poison, which is seeking an entrance to the system, then the treatment must be directed chiefly to the constitution. The course will be that which is followed when secondary symptoms have presented themselves. So far as the chancre is concerned, the patient will be anxious to have it healed. Under such circumstances mercury may be cautiously administered to break up the chancre.

Treatment of the Soft Chancre.—Local applications alone are necessary. The nature of the application will depend upon the character of the sore, for all soft chancres are not alike. The sore may be confined to the surface of the part, or it may involve the sub-tissue. Sometimes the poison seems so virulent that it induces ulcerative action or sloughing, or even gangrene. This may not be altogether due to the character of the poison, but rather to the state of the part, or the system of the individual. A part which is filthy is more likely to suffer. A person whose habits are irregular, who is intemperate, whose blood is vitiated from excess, may have "phlegmonoid suppurating sores," or ulcerative inflammation, or sloughing, or even gangrene in the part which has been exposed to the syphilitic pus.

When the sore is quite on the surface, and even when the subjacent cellular tissue is but little involved, the treatment will be comparatively plain. But when the cellular tissue is more deeply concerned, something decided may be requisite. The application of caustic is commonly recommended. When applied it should be most thoroughly done, otherwise it would seem to be attended with some little danger. It should be so done as to destroy the whole

of the tissue in which the poison may reside; because sometimes a soft chancre unexpectedly takes on the character of the *hard*, indicating the greatest danger of constitutional infection. And the use of the caustic will in some cases be followed by this change. However, we may venture to suppose that were the poison entirely reached, induration of the sore would not ensue; that it is the presence of the poison in the tissue which, influenced by the cauterization, leads to the unfortunate result—the formation of adhesive lymph.

It must be continually borne in mind that the soft chancre will not be followed by constitutional infection so long as it remains such, but that it may become a hard chancre when exposed to such influences as will beget adhesive inflammation. Suppuration should be promoted, for thereby it may be hoped that the poison lodged in the part will be discharged. To destroy the tissue the nitric acid should be employed; its action is thorough, and is not particularly likely to be followed by a change in the nature of the sore.

When the syphilitic sore is attended with *ulceration*, or *sloughing*, or *gangrene*, the treatment will necessarily be prompt. Whatever may be the cause of the destruction of tissue by the poison, whether it be due to the vitiated state of the individual from whom the poison is derived, or to the one who has received it, the treatment will be of the most decided kind. The poison is causing destruction of tissue. The first, the only step indeed, is to promptly destroy the tissue in which it is producing its destructive effects. Here again the nitric acid will prove the best. (*Vide* Ulcers.)

Treatment of Buboes.—It will be remembered that the soft, non-infecting chancre, is the most likely to give rise to swelling and suppuration of the glands at the groin. It would seem that a certain quantity of the syphilitic virus is taken up by the absorbents, but that it passes not beyond the first glands. Being detained by them it creates inflammation, and finally suppuration. When the pus, in the form of an abscess, escapes from this bubo, all the virus that has entered the body is cast off. But, in the case of the *hard* chancre, these glands do not always escape. They do not become inflamed; but they will be found indurated and somewhat enlarged. The lymph effused in the gland quickly coagu-

lates. As a general thing, when this condition of glands exists, the constitution is already involved; constitutional syphilis will ensue. It is thought, by some recent writers, that the avenue by which the virus enters and infects the system is not by the lymphatic system of vessels, but directly through the blood circulating near the chancre. This may be regarded as an unsettled question. When the glands at the groin are found hard and painless, as it indicates constitutional disease, the treatment will at once be directed to the system. The use of mercury will no doubt hasten the dispersion of the indurated mass. The tincture of iodine is very often used. I cannot say I have seen, as a general thing, any benefit from its use. But I have found the application of belladonna to be followed by prompt and marked benefit. These indurated glands may remain for months without giving any special trouble, except so far as it exercises the fears of the patient.

The treatment of the *suppurating gland* will in no way differ from that of ordinary acute abscess. The pus should be let out as soon as detected. If the patient manifests a tendency to prostration, generous diet will be much required.

Constitutional Syphilis.—We have learned that the constitution in many cases becomes infected with a blood poison. The subtle element, introduced at the part where the chancre forms, finds its way into the volume of blood, and sooner or later, according to circumstances, it is so multiplied or becomes so developed that a formidable and destructive disease pervades the whole system. And the disease thus established may remain, notwithstanding all treatment, for a lengthened period of time; sometimes it seems to be incurable. The symptoms may from time to time disappear, under the use of certain drugs; but too often they reappear, or a new phase of this Protean malady presents itself.

Period of Incubation.—The duration of time between the reception of the virus and the constitutional display of symptoms is not always the same. They may appear in three or four weeks, or as many months may elapse before the so-called secondary syphilis is established.

Symptoms.—The constitutional disease is ordinarily initiated by a slight irritative fever, and disturbance generally of the functions of the body. Soon thereafter will appear a characteristic erup-

tion upon the skin. The mucous membrane may also be affected, which will be indicated by soreness of the throat.

Varieties due to Adhesive Inflammation.—And here, I venture to think, is an indication of nature to which particular attention ought to be paid. The syphilitic poison in the system is not there allowed to remain, with no effort to eliminate it. Instead, we see an early attempt to cast it off. It seems to be through the skin and mucous membrane that this work is undertaken. And it is the presence of this syphilitic virus, passing through the skin, that produces this exanthematous eruption. This shows how intensely poisonous it is. Its presence at once begets irritation, and often inflammation. The inflammation maintains the peculiarity exhibited in the primary sore. It is always adhesive. The consequence is, that the poison, in greater or less quantity, is detained here and there. We see it in minute points in the eruption, but it will be found in larger portions at times, not alone in the skin, but, later in the disease, in other structures of the body. This variety as to mode and quantity of virus begets an equal variety of secondary, not to say tertiary, symptoms; and we have the roseola; lichen; syphilitic tubercle; syphilitic lepra; syphilitic psoriasis. (Henry Lee, Syst. Surgery.) In all of these there is the adhesive inflammation, which by its very action interferes with the eliminating process. As before said, one of these conditions may disappear, to be followed by another.

Varieties due to Suppurative Inflammation.—But the inflammation arising from the virus is not always adhesive. It may be so for a time, but at last it takes the suppurative form. Pustular eruptions as the first constitutional symptom very rarely occur, yet sometimes they do appear. At a later period, the fibrin is more likely to degenerate into pus. Arising therefrom may be seen syphilitic impetigo, or syphilitic ecthyma. (Cazenave, Syst. Surgery.) Sometimes serum only is effused, and there is formed syphilitic herpes, eczema, &c. (Lee.) These varieties of eruption, tubercles, and pustules, may be found upon the skin or mucous membrane, but perhaps more frequently on the skin.

Tertiary Symptoms.—But the action may not be alone suppurative, but also ulcerative. The virus at first provokes adhesive inflammation. The half-organized fibrin which results may after a time not only perish, but likewise involve the adjacent natural

tissue. In this way great and extensive destruction may take place, constituting the so-called tertiary symptoms.

Liability of certain tissues to become involved.—The disease remaining in the system for some time, there are certain tissues and structures which are more frequently the seat of further deposit. The iris is very often affected, forming syphilitic iritis. This, however, is commonly included among the secondary symptoms. The poison not being removed from the outer membranes, the subcutaneous and submucous structures will gradually become involved; then the deeper fibrous tissues, as the periosteum and the bone; also the joints, and the testicles.

The *tertiary symptoms*, then, are characterized by a more extensive destruction of tissue than before effected. The skin will ulcerate or slough in much larger quantity, especially about the scalp. The mucous membrane of the mouth and throat may be destroyed to a distressing and alarming extent, even so as to prevent deglutition and produce death. At the same time, the periosteum may be, in places, very much thickened by half-organized lymph, constituting syphilitic *nodes;* or the bones may be involved, leading to necrosis, or caries. Again, the joints may be the seat of chronic inflammation and degeneration; also the testicles may be immensely enlarged, or destroyed by atrophy.

Treatment.—Having now traced the disease in its onward progress, and endeavored to give the more prominent symptoms of the various forms of constitutional affection, the question may be asked, whether anything can be done to arrest this fearful malady, at least to palliate it?

The fact has already been stated that nature seemingly endeavors to get rid of the destructive virus, but that in these efforts she is hindered by the adhesive inflammation which the poison begets. In the first place, when an individual has been the subject of an indurated chancre, he ought to commence at once a course of most regular life. Inasmuch as the skin seems to be the channel by which the poison is to be eliminated, it should be daily cleansed by washing and thorough rubbing. And even when the eruption presents itself, the bathing ought not to be discontinued. As well, attention should be paid to all the rules of diet and hygiene.

With respect to the administration of medicines to cure the

disease, it may be remarked that no little difference of opinion exists; and when such is the case, some doubt may be felt as to whether any one medicine has yet been discovered which has the power to cure this disease. The drugs which stand first are mercury and the iodide of potassium. Sarsaparilla has enjoyed a high reputation as a curative agent; but I speak from experience, and the concurrent testimony of not a few, when I say it possesses no peculiar virtues as an antidote to syphilitic poison.

Mercury, in one form or another, is regarded by some as an antidote to the virus. I will give the words of a recent writer. (Henry Lee—Syst. of Surgery.) He says: "There is one medicine alone—mercury—which, through good report and evil report, in spite of the strongest prejudices of some against its use, and the no less adverse influence of others who have employed it to an unjustifiable extent, has maintained its general reputation.

"From within a short time of the recognition of syphilis as a specific disease to the present, mercury has been extensively employed in its treatment; and during the whole of that time, the majority of surgeons have regarded it as the most efficacious of all known remedies. It must be admitted that mercury has been often injudiciously given, and that it consequently has done much harm. It has nevertheless maintained its reputation, and it may be safely affirmed that general experience has proved that no remedy exists possessing so great a power to extinguish the venereal poison as mercury. The iodide of potassium, to which allusion has been already made, possesses in an eminent degree the power of removing some forms of secondary eruptions, but does not, according to my experience, either prevent the occurrence or the recurrence of the disease in the same way as mercury.

"There are three different ways of administering mercury. It may be given internally, in pills or solution; it may be introduced into the system through the skin, in the form of ointment; or it may be employed as vapor, also, applied to the skin."

Mercury versus Iodide of Potassium.—Notwithstanding this high authority, I would respectfully submit that full justice is not done to the iodide of potassium, as a curative agent. It must be conceded that a drug which has the power, "in an eminent degree, of removing some forms of secondary eruptions," must possess some specific virtue. It is not argued by the above-mentioned

eminent writer that it merely suppresses a disease, which afterwards exhibits increased virulence, but that it does not "prevent occurrence or recurrence of the disease in the same way as mercury." Now, the various secondary symptoms which are presented must be regarded as efforts of nature to eliminate the virus; and if a drug has the virtue to remove these symptoms, it must to a certain extent prove an antidote to the poison—at least it assists in its elimination. And if the medicine be continued diligently for a sufficient length of time, I must say, I think almost or quite as much benefit will be experienced by the patient as would be obtained by the use of mercury. But that is not all. Iodide of potassium is not likely to produce evil effects upon the system; whereas the exhibition of mercury, even when judiciously used, may be productive of disastrous results.

Mercury is recommended as the most efficacious medicine in all stages of the disease; to prevent, as well as to cure. If we are expected to look upon mercury as a direct antidote to the poison —as a medicine which possesses the power to annihilate the virus —I submit that the evidence is wanting to substantiate such a view. That mercury has the power to break up the spots of adhesive inflammation, is well understood. Herein would seem to consist the only virtue of the drug; because, when that is effected, a chance is afforded for elimination. But, as we have seen, the *iodide of potassium enjoys the same reputation*, though to a less extent.

Taking all in all, must it not be regarded as a safer mode of treatment to faithfully try, in the first place, the iodide of potassium, and then, should it fail to accomplish what is required, after due trial, resort cautiously to the more potent and at the same time dangerous drug—mercury?

The aforementioned writer recommends, as far the best mode of using mercury, calomel fumigation. "None is attended by so little mischief to the patient's constitution," a most important consideration, "and none is followed so seldom by a relapse." "Mercurial inunction," he says, "is a very efficient way of using mercury; but it is dirty, laborious, and often little suited to the taste of those who require its aid." The following is the plan of fumigation practised and recommended by this writer. It can be well recommended to those who wish to employ the drug: "It

(the apparatus) consists of a kind of tin case, containing a spirit-lamp. In the centre, immediately over the wick of the lamp, is a small circular tin plate, upon which the mercurial powder is placed. Around this is a circular depression, which is half-filled with boiling water. The patient places this on the ground, and sits over it, or near it, on a small cane stool. He is then enveloped, lamp and all, in a circular cloak, made expressly for this purpose by Messrs. Savigny. When a cloak cannot be procured, a double blanket answers the purpose very well. At the expiration of a quarter of an hour or twenty minutes, the calomel which is placed upon the lamp, the water, and the spirit, will have disappeared, and the patient may then get out of bed.

"During the time the patient is taking the bath, he may inhale the vapor for half a minute or a minute, on two or three different occasions, with advantage; and after the bath is over, he must contrive not to wipe off the calomel deposited upon his skin. Patients are usually recommended to sit over the bath for two or three minutes after the lamp has gone out. They are then sufficiently cool to put their day or night shirt on, as the case may be, without disturbing the calomel on the surface of the skin. A portion of that which is left there becomes, by a slow process of imbibition, absorbed into the patient's system.

"Amongst the poor, a less expensive apparatus is convenient. Half a brick is directed to be heated to a dull red heat, and then placed in a pan having a little water in the bottom. On the top of the heated brick the mercury is placed. The patient then sits over the pan for twenty minutes, with a large blanket, reaching down to the ground, round his neck. It will be noticed that in all these arrangements, provision is made not only for the volatilization of the mercury, but also for presence of water in a state of vapor. This is important; for practically, it is found that the mercurial action is more certainly produced and more steadily maintained when mixed with a certain quantity of vapor of water, than in dry air."

These modes recommended by Mr. Lee are the least objectionable ways of using the drug, and it may be that the desired effect can be secured without exposing the constitution to those terrible effects sometimes seen. This treatment is followed at all stages of

the disease, whether it be the primary indurated chancre, or ulcerative destruction of the tertiary symptoms.

For treatment of syphilitic ulcers (tertiary symptoms), see Ulcers.

CHAPTER XIX.

Erysipelatous Inflammation — Causes. Varieties: 1. Simple; Symptoms — Treatment: Local — Constitutional. 2. Phlegmonous; Pathology — Treatment.

This is the last form to be noticed. One of its chief characteristics is a tendency to spread, both by continuity and contiguity. It may extend along the skin or the mucous membrane, or to the subjacent cellular tissue. The inflammation is the *result of a blood poison*, which has been gradually developed in the system. It is probably due to the introduction of some decaying matter, either animal or vegetable. It is a disease in many respects like pyemia, and no doubt may be generated in the same way as that disease; or it may be the result of some extraneous substance which has found entrance to the blood, often by inhalation. A period of incubation passes, during which there is no doubt a process of zymosis, and by which the poison attains to its power to create a local inflammation. It is not improbable that the local manifestation is an extraordinary effort of nature to eliminate the poison, at least when the disease is upon the surface of the body. Otherwise, it may be regarded as truly a disease of the tissue, because that tissue, being weak, or irritated, or injured, could no longer resist the fatal influence of the poison which had been developed in the blood.

Symptoms.—This affection is characterized by the various phenomena of inflammation, although they are very much modified. Stagnation of blood takes place very quickly; the coats soon are dilated and paralyzed, and seem to be quite incapable of resisting the pressure made by the blood circulating therein. The result is rapid transudation of serum and liquor sanguinis with the coloring

matter of broken-down red corpuscles, which are dying very rapidly. It is the presence of this hæmatine in the transudation which gives to the part that intense redness which is also characteristic of the disease.

Causes.—The causes, already referred to, may be divided into *predisposing* and *exciting*. Anything which vitiates the system, or impairs its vitality, thereby making it more susceptible when exposed to the morbid influences, is a predisposing cause. Of the exciting, there may be mentioned *infection*, *atmosphere*, *epidemic*. With respect to the first, it must be remembered, as a fact of considerable practical interest, that the disease may be conveyed from one individual to another, and in various ways. It can be carried from one house to another; and in the hospital, from one ward to another. The vehicle may be the surgeon, the nurse, a bandage, or a sponge; indeed, anything which has been used about one afflicted with the disease. This shows with what care the attendants upon such should proceed; how necessary it is to destroy everything that has been used about the afflicted, and to thoroughly cleanse the hands before approaching another patient. The poison emanating from an erysipelatous sore is sometimes also conveyed by the air to a healthy sore, and changes it into an erysipelatous one. At times, there is an epidemic of erysipelas; it will prevail in a locality for a time, and then disappear.

Divisions.—Various divisions of erysipelas are given by writers. It may be made into *idiopathic* and *traumatic;* also *symptomatic*. The first form belongs more especially to the science of medicine, and the second to surgery. The most useful division is into *simple* and *phlegmonous;* and these may be said to embrace every form of the complaint, however caused, and whether it be idiopathic or traumatic. The simple is confined to the skin or mucous membrane. The phlegmonous involves the cellular or deeper structures.

But there are other kinds mentioned: kinds which have received their distinctive names on account of some prominent or prevailing feature. These it will be sufficient to mention. They are: *œdematous*, because of œdema; *cellular*, where the cellular tissue is principally affected; *bilious*, in which there is derangement of the biliary apparatus; *erratic*, characterized by a disposition to move from one part of the skin to another; *periodic*, so called from its

coming periodically, without any adequate cause; *hospital*, due no doubt to want of cleanliness, bad ventilation, or other neglect of hygienic rules.

Symptoms of erysipelas may be divided into *local* and *general*. The constitutional symptoms of the simple and phlegmonous are the same, with this difference: that in the phlegmonous they are more decided in their nature—are better marked.

The *local symptoms* are the same as in healthy inflammation, viz.: *pain*, *heat*, *redness*, *swelling*. The *first* is sharp and stinging—a sensation something like burning. There is generally exacerbation at night. "The inflamed part is *hot* and painful; at first, a stinging or itching is felt, which soon becomes a sharp, smarting, and burning sensation, with acute pain on pressure. The pain is not so intense and unremitting as in phlegmon, nor is it attended with throbbing." (Lawrence.) *Redness* is always a prominent feature, and sometimes is very bright, in consequence of which it has been designated the rose. It is not due simply to an increased quantity of blood in the part, but to a common infiltration of liquor sanguinis and the coloring matter of the blood. A peculiarity of the redness is that it has well-marked borders; the line of demarcation between it and the healthy skin is distinct. If pressure be made upon the part, the redness momentarily disappears. *Swelling*, as a general thing, in the simple form, is not present; but sometimes there are small vesicles over the reddened surface. This generally indicates a serious attack, and a danger of extension by contiguity to the subcutaneous structures.

Constitutional Symptoms.—In the first place, there is a feeling of lassitude, with headache; then, considerable depression, perhaps great prostration. The whole of the alimentary canal is disordered. Commencing with the mouth, it is found dry; the tongue is furred, or coated, and exhibits a tendency to become brown; the stomach is at first somewhat nauseated, and food is distasteful, and digestion seems impossible; the bowels are generally constipated; the liver is sluggish, perhaps congested, which will be indicated by pain in that region. When the liver is thus involved, the disease becomes the *bilious* erysipelas. Fever, with dryness of the skin, is at times very considerable; not, however, so great as in the healthy form of inflammation.

The *course* and *termination* of simple erysipelas will depend

somewhat on circumstances, but generally it runs its course to a favorable issue. In those cases where a tendency is manifested to extend to the deeper tissues, the result is less likely to be favorable. The disease, although inflammatory, yet being due to a blood poison, which for elimination requires time and suitable conditions of the organs of secretion, cannot, like ordinary inflammation, be cut short. It must run a certain course; and while such is being done, the products before mentioned exhibit a quick tendency to affect the tissue in which they are infiltrated. The effused material is strongly impregnated with the erysipelatous poison, and softening and ulceration speedily follow this abnormal inflammation. In the truly simple form, the products are very limited, and consequently the effect upon the membrane is very slight. But very often the simple form becomes phlegmonous; in such cases, the products are more remarkable and injurious; and the result to the constitution will be correspondingly great, causing very great prostration, and, if the system be weak, terminating in death.

Treatment of Simple Erysipelas.—The disease may not be aborted, or brought to a termination by treatment, like as in acute inflammation, although it may be somewhat abbreviated. The principal point in the treatment is to control the inflammation; to limit it to the part already involved; and should products result, give due attention to them. The strength of the patient must be maintained, by suitable means, until the poison shall have been eliminated.

If the local inflammation can at all be regarded as an effort at elimination, and that the poison is concentrating in the part for that purpose, it can be readily understood that no effort ought to be made to disperse the inflammation, inasmuch as the disease may disappear in one place only to appear in another, and where it will be less tractable—less easily controlled. I have seen some cases of idiopathic erysipelas of the face, in which powerful means were adopted to cut short the inflammation, and which, having accomplished the object aimed at, was followed by metastasis to the brain, terminating in death. Whether the above-mentioned theory be correct or not, there can be no doubt that to control the local manifestion is the utmost that should be sought for.

The disease is prone to spread by continuity; to stop this,

abundant experience has shown that a solution of Nit. Argent. will prove highly efficacious. The application should be made not to the surface of the inflamed part, but to the tissue around it, allowing a distance of something like an inch to intervene between the affected portion and the part to which it is applied. The caustic so alters and disorganizes the integument, that those changes necessary to the inflammatory process cannot take place, and thus a barrier is formed, beyond which the disease will not be able to spread. The circle of coated skin must be complete; for if the slightest space be untouched by the solution, along it the redness will extend, and, when outside, thence spread on every hand. The solution of silver ought not to be applied to the part which is red, as it is very likely to cause the disease to extend to the deeper structures.

To prevent the disease from extending to the subjacent tissue by contiguity, and to abate the existing inflammation, various applications have been recommended. It must not, in using any application, be forgotten that the inflammation is not to be directly arrested, but rather the cause should be removed, and that thereafter the disease will naturally incline to stop. To limit the disease, sedatives and astringents may be advantageously employed. Cooling lotions are often beneficial; and, on the contrary, warm applications may give great relief, more especially when there is much tension of tissue by effusion of liquor sanguinis. Tincture of iron, or sulphate of iron, may be applied with very decided benefit. The iron acts as an astringent, and, as well, seems to have a specific effect upon the poisoned fluid in the part. It appears to supply vitality to the blood: at least a greater degree of vitality is exhibited by it. Possibly the iron acts directly upon the poison which is concentrated in the part, and destroys it, curing the inflammation, and at the same time the cause of it.

Oleaginous applications are now and then comforting to the irritated nerves. The presence of air seems to cause some of the irritation, and if it be excluded the pain will be lessened; hence it is that oil affords relief. Flour may prove likewise beneficial. Collodion has also been used. The tincture of iodine has been highly recommended; but it ought by no means to be used indiscriminately. When the irritation is great—the action running high—the iodine will only augment the already too great action.

As an application, it is more particularly useful in the œdematous form, when there is a want of acute action, there being passive congestion instead of active.

In the more serious form of this simple erysipelas, when vesicles are seen upon the surface, and extensive effusion seems to be taking place, the more prompt and suitable treatment is to make small punctures, so that the blood, almost or quite stagnating, may escape.

Constitutional Treatment.—Sanitary rules must be duly observed. The primæ viæ, being generally deranged, will have to receive attention. If there is indigestible food in the stomach, an emetic to remove it will be well. The liver, always torpid, should be aroused to action by a full dose of calomel and jalap. To treat the disease itself—to destroy the poison in the system—I know of nothing more useful than the tincture of iron, in doses of from fifteen to twenty-five drops every three or four hours. The powers of life must be sustained by stimulants and by beef tea. With respect to alcoholic stimulants, there is a difference of opinion. The late Dr. Todd was a strenuous advocate for its use. He contended that brandy not only acted as a stimulant, but also as an antidote to the erysipelatous poison. According to the cases adduced by him in his work on "Acute Diseases," his success in the treatment of erysipelas was very great. But other authority, equally high, declares that the disease can be governed without much, if any, alcoholic stimulants. From not a little observation, I feel no hesitation in offering the opinion that, in the worst forms of the disease, nothing can take the place of alcohol, administered in one form or other. If plenty of beef tea can be taken, the stimulant may be unnecessary; but otherwise, brandy will be required to sustain the powers of life.

Phlegmonous Inflammation.—It has already been observed that by this is meant those cases where the sub-integumental tissues are involved. The disease may at first have been simple, and then have merged into the phlegmonous. The tissue affected may be the cellular tissue, or perhaps the meninges of the brain. It is by far a more serious and fatal form of the malady. Our attention will be more particularly directed to the cases where the cellular tissue is the seat of the inflammation. At the very first sight, it will be seen to be a more grave and serious affection than

the simple form. The characteristic redness is not so bright, but it is deeper in hue. In the simple there is little or no swelling; in this there is a good deal, which is more diffused. To the redness there may be a distinct line of demarcation, but the swelling is not circumscribed. Into the cellular tissue is at first determined a large quantity of the vitiated blood. Rapid distension and paralysis of the vessels follow, attended by free effusion of liquor sanguinis of a low grade. Very soon there is a complete stagnation of blood in the part, while the cellular spaces are distended with fluid, colored with the hæmatine. Following, will soon be found a degeneration of the ill-conditioned fibrin into pus correspondingly low. There will be no collection of pus here or there, the matter being distributed through the cellular tissue. While these morbid steps are being taken, one after another, the *swelling* is gradually increasing; and, in accordance with the general rule, the *pain* is considerable, sometimes very great. There is a tendency to speedy ulceration and destruction of the engaged structures; sometimes there is even sloughing.

These more formidable symptoms in the part are attended by equally prominent constitutional symptoms, which approach to the typhoid kind. All of the constitutional derangements specified in the simple are here present in an intensified form. The disease is generally ushered in with a well-marked rigor, which may be repeated. The tendency to prostration is constant and often alarming, especially when there is delirium.

The *result* and final *termination* may be the most serious. The inflammation is very likely to spread and involve the deeper structures, and to extend along the subcutaneous cellular tissue. The constitution is in danger of succumbing to the combined effects of the blood poison and the local disease. The resources of the surgical art will be required to give prompt and decided assistance.

Treatment of Phlegmonous Inflammation.—The surgeon's attention will be at once directed both to the local affection and the constitutional malady. The danger of ulceration, and sloughing of the tissue, must be constantly regarded. The pain is distressing. It is due to transudation of morbid lymph, which, may be, has degenerated into pus. To relieve this, the first efforts will be made. In very many cases, I have seen the best effects result

from swathing the part in flannel wrung out of water as hot as can be borne by the hand. It is a sedative, and relaxing to the over-distended tissue. Sometimes, on the contrary, the heat increases the pain, when of course it ought at once to be discontinued. The only course now is to make free incisions completely through the diseased structures. Let them be short cuts, but as numerous as may be necessary to secure a free discharge of the effused lymph, or pus—whatever fluid may be in the tissue. Thereafter, hot fomentations will do good service by alleviating the pain due to cutting, and by promoting the escape of the blood, lymph, and pus in the part. These incisions are necessary, to save ulceration and sloughing. No matter where the seat of the disease, the knife must be used. The scar resulting will not be so unseemly as that deformity which would otherwise result, not to speak of the danger to which the life would be exposed. When the face is the seat of disease, the hesitation to use the knife may be great; but it must not be forgotten, that when the swelling subsides, the wound will very much diminish, so as to very materially lessen the scar.

The general treatment must be the most vigorous, supporting the strength by often repeated stimulants, so as to keep the tongue moist. The essence of beef should be given as freely as possible.

The other forms of erysipelas which were referred to do not require any separate notice, in this work, with respect to treatment. In every case the disease is the same, only that in some cases the constitutional poison is more active, more virulent; and that in some individuals the constitutional or local weakness causes complications. When these varieties of the disease present themselves, the treatment will be modified to meet the requirements of the case.

DIVISION II.

THE HEALING PROCESS, AND DISEASES OF THE HEALING PROCESS.

CHAPTER XX.

The Healing Process, Ordinary and Extraordinary; Repair of Tissue—Material for Repair—Fibrin.

PERHAPS there is no subject in the whole range of the surgical science which can supply so much food for pleasant thought, in its investigation, as the healing process. Indeed, the surgical science, I venture to say, is based upon its principles.

In the course of our examinations of the phenomena of inflammation and its results, we have caught many glimpses of the ready efforts of nature to repair, of the wise steps she is ever taking to secure that end, and of the varied modes by which she brings forth her resources for its accomplishment, whenever and wherever they may be required. After inflammatory disease, just so soon as it has subsided, and physiological action can supersede the pathological, the simple but many-phased operations of nature begin to display their wondrous doings. While we have had many glimpses, now and then we have had clearer views of her all-sufficient power.

From the time fibrin begins to increase in quantity and vitality, as the effect of inflammatory action, and the dilating capillaries begin to show a sacculated condition—increasing often to prolongations—until healing by granulation is in full activity, to repair a broad or deep breach (which has been made by disease), continued and successful efforts to heal are ever manifested. So striking are these displays during what is generally considered only a morbid process, that the thought cannot be repressed that the inflammatory process should be regarded rather as one of many ways to heal—that it is a first and necessary step to the attainment of a great object. In other words, healthy inflammatory action is a

process entered upon to throw off a morbid material, local or general; or to prepare a way to expel and carry off a foreign substance, the presence of which is inimical to the health of the part, and which precludes the possibility of restoring the part, which has departed from its normal condition.

We have already seen (*vide* Chapter I), and it is a well-known fact in physiology, that the body is subject to incessant decay; that every tissue of the body is mutable. The individual particles have a life of their own, which is very brief compared to the life of the whole body; and this life may be shortened by use. This never-ceasing "wear and tear" of the body would soon undermine the human structure, were not repair as constantly taking place. Thus it is, that, day after day, ordinary repair is made in every tissue of the body. Now, it would seem that the healing process is but a modification of *ordinary* repair, and that it may be designated a process of *extraordinary* repair. By it, nature displays her power to meet the varied contingencies which wait upon mortal man. There is not only ordinary decay of tissue, but there is from time to time a more palpable destruction of tissue. By the process of inflammation, or ulceration, or sloughing, or gangrene, or from a wound or mechanical injury, a breach may be at any time made. While such destruction is uncertain as to frequency and extent, yet the body is never exempt from danger; at no period of life does it enjoy immunity from these accidents. And for the well-being of the body, for its preservation, it were quite necessary that preparation should have been made to meet the wants when they might be felt; to effect extraordinary repair, when there should occur extraordinary destruction. It is this which is manifested in the healing process.

Repair in Lower Animals.—It is not only interesting, but instructive, to notice the fact that the provision to restore parts exists in the lower forms of animal life to a very great extent. It has been fully ascertained (Paget) that this extraordinary power to repair is exhibited in an inverse ratio to the degree of development which characterizes the animal. That is to say, when much strength and vitality is required and exhausted in the development of the body, there will be a corresponding want of power to effect extraordinary repair when called upon to do so. On the contrary, when the powers of development are low, there

is, to some extent, a compensation in the ability to restore lost parts. Thus, while in man a limb may not be restored when separated from the body, the hydra, when divided into many parts, has in each portion the power to reproduce all the parts from which it has been separated. Animals, then, whose powers of development are low, and which are, seemingly as a consequence of that want, more exposed to injury and death, have supplied to them an equivalent by which death and extinction of the species are averted.

The ability to restore is in man comparatively limited. In the young, however, it exists in a much higher degree, gradually declining as life advances and growth and development progress. The less the power which has been expended in development, the more quickly and the more extensively can nature do repair. So far is this true, that the child, while in utero (as there seems to be convincing proof), can in some cases have restored a finger or toe, when either has been lost by intra-uterine accident; a power to repair never known in the child after birth. Again, cases are recorded where a whole limb has been amputated in utero; and although not altogether restored, there was found, growing from the stump, fingers or toes, as the case might be. And it is a fact of great practical value, that in childhood, and during adolescence, the healing is both speedy and more extensive; while in middle age, and especially in old age, the process is often tardy and imperfect.

It was thought expedient to thus call to mind the physiology of ordinary repair, and to make these preliminary remarks relative to the subject to be considered.

The Special Agent for Repair.—We may now proceed to discuss the question, What is understood by the Healing Process? What is this process, by which restoration is secured and lost tissue regained? Physiology explains to us the process of ordinary repair, called nutrition; by it we learn that the blood coursing through every part of the body washes away the *debris*, and at the same time supplies the necessary elements to form new structures. This fact furnishes the surgeon with light, to more successfully examine the method by which healing is carried on.

Is the material for ordinary repair the same as that which is demanded for extraordinary repair? In the first steps of healing,

the material seems to be quite dissimilar from that appropriated in nutrition, although derived from the same source. It is from the blood that is obtained the great primary agent employed by nature to heal, and that agent is undoubtedly the fibrin. It is the fibrin which performs this most important duty, second only in importance to nutrition and growth. Whatever other purpose the fibrin may serve, this is the principal object, seemingly, for which it exists; and it is a function sufficiently high, so that those who have been wont to regard fibrin as the pabulum of the tissues, have no reason to think that in losing that status it has sunk into insignificance. Can it be thought unlike the doings of nature to suppose that she specially prepares a material for *extraordinary* repair—for restoring parts more palpably destroyed? Judging from numerous facts and data in the possession of our profession, one does not hazard much in venturing the opinion that this is the principal, if not the sole, use to which this element of the blood is intended to be put.

This view has forced itself upon my mind, and it is in accord with physiological and pathological facts. The fibrin is an element of the blood which primarily was capable of entering into the process of nutrition; but not being required, it is left to undergo a change by which it is made to occupy a grade somewhat lower in the scale of vitality. We cannot suppose that the supply of food, and that part of the blood which is the most highly vitalized, and intended for the nutrition of tissues, will always be just coequal to the demand; nor can we admit that the supply in health is ever *below* the requirements of the body. Consequently, we may reasonably suppose that there is often, or always, found in the blood of the body more material for nutrition than can be made use of. The elements of the blood, like the tissues of the body, have their day of growth, development, maturity, decline, and of death. When the tissue's food has reached its highest state of vitality, it is fitted to form a part of the most delicate organ in the frame. But should it not be required,—and we have seen that in all probability there is commonly more than the tissues do want, —then degeneration sets in, and that portion will have passed the meridian of its life, and thenceforward cannot possibly take a part in ordinary repair, but may, if required, take a part in extraordinary repair. Not, it is true, to be assimilated to the tissue; but

to constitute a temporary structure—a scaffolding, whereby the permanent and the natural edifice shall be built.

I would liken the fibrin to refuse timber, which can always be seen strewn about a building in the process of erection. It has been rejected, not only because better were available, but because other and enough were more convenient. This material, thus declined, is regarded as a waste substance, and, in consequence of its being thus regarded, is subject to deterioration. Now, this timber, which has failed to form a part of the edifice for which it was prepared, may yet discharge an important duty by being employed to construct a temporary stage, or scaffold, by which the permanent structure shall be completed. So the fibrin. Yesterday, under another form, it was perhaps qualified to enter into the formation of tissue. To-day, in the decline of life, it is no longer fit to accomplish so high a purpose; yet not so degenerated but it may answer a temporary use in the work of extraordinary repair.

Several facts seem to support the view advanced; two particularly: first, the very small quantity of fibrin in the blood when the body is in a state of health; second, the well-known fact that fibrin increases in a part as soon as the inflammatory process commences—that it is elaborated in excess immediately upon a prospect presenting itself of it being required to restore the part. And there are other facts which serve to corroborate the theory, which will become apparent as the healing process, in its several forms, is duly considered.

We have seen already that even the inflammatory process may be looked upon as a means to secure an important end,—the healing process. But when inflammation is really established, what are the marks by which we can trace the footsteps of nature in the great work of healing? An early product of the inflammation is liquor sanguinis, the fibrin of which stands ready to commence the work of repair the very moment an opportunity presents itself; not only this, but its presence seems to do much, at times, in arresting the disease. The serum having separated from the fibrin, the latter begins to coagulate and to contract. By this means, the tissue in which the inflammation is seated becomes fixed to a degree, and the part is thereby placed in a state of rest, so essential to arrest the inflammatory action, and to allow the healing to commence. This is more particularly observed, as before men-

tioned, in serous membranes. In the abdomen, for instance, the viscera, constantly moving in the discharge of function, or under the influence of disease, will, as a consequence of inflammatory adhesions between serous layers, become fixed, more or less, thereby arresting the morbid action. And it can scarcely be doubted that in every part of the body, when the fibrin stiffens in inflamed tissue, it, by securing rest, has a beneficial effect, although in a less marked degree. Even when a portion of fibrin degenerates into pus, and an abscess is formed, fibrin will be found around the pus in a coagulated state, so as to form a barrier, that the pus or *debris* may not enter the system. And if, in connection with the abscess, an artery be endangered, the fibrin will form an extra covering or coat to the vessel, to preserve the coats from harm. And should the process of ulceration extend to the arterial tissue, and the tube be penetrated, it will be found that, before this could occur, the artery within had been closed by a plug of fibrin; and thus hemorrhage is averted. When we come to consider the subject of wounds, it will be seen that fibrin is the effectual agent by which a divided artery is permanently closed; and likewise in aneurisms, it is by it that a cure must be made. It was necessary to thus refer to these several modes by which fibrin is known to act in furthering or effecting a cure in inflammatory disease. We are now prepared to examine the healing process, as presented in the restoration of tissue actually and palpably destroyed.

CHAPTER XXI.

Five Methods of Repair—Immediate Union—Primary Adhesion—Granulation—Second Intention, or Second Adhesion—Under a Scab, Cicatrization—Requisites for Granulation.

ACCORDING to Paget, there are five ways by which the healing may take place; but we shall learn that each is a modification of the others, and that, in each, fibrin is the great agent by which the work is accomplished.

The five methods are: 1. *Immediate union.* 2. *Primary adhesion.* 3. *Granulation.* 4. *Second intention, or secondary adhesion.* 5. *Under a scab.*

Immediate union may take place between the surfaces of a wound when there has been a very smooth cut; when the tissue has been divided by the sharpest of instruments; and when neither bruising nor tearing has in the slightest degree attended the wound. If a part thus divided be immediately placed in a state of absolute rest, the bleeding having entirely ceased without external aid, and the surfaces having been brought accurately together, so that each tissue sustains the same relation it did before division, nerve against nerve, vessel against vessel, an immediate union may take place, and the blood very soon be found traversing the vessels which had been severed. There will be no perceptible bond of union between the surfaces thus brought and retained together. For a brief time, there is undoubtedly a stratum of fibrin; but, the part being at rest, and the tissue uninjured, and the slight irritation caused by the cut departed, the fibrin is not required, so that before it can become solid by coagulation, it is carried away by the absorbents. The wound is rapidly and perfectly healed. This process is of rare occurrence; but that it can and does now and then take place, there is no doubt, and that sometimes extensively. The following case, recorded by Paget, is instructive. It is of "a woman thirty-three years old, whose breast and several axillary glands were removed for cancer. Her general health seemed good, and all went on well after the operation. The flaps, which were of course very large, had been carefully laid down, strapped with isinglass plaster, and well attended. They appeared to unite in the ordinary way, and there remained only a narrow space between these retracted edges, in which space granulations arose from the pectoral muscle. Three weeks after the operation, these were making good progress toward cicatrization; but erysipelas and phlebitis ensued, and the patient died in four or five days.

"I cut off the edges of the wound, with the subjacent parts, expecting to find the evidences of union by organized lymph, or possibly blood. But neither existed, and the state of the parts cannot be better described than by saying that scarcely the least indication remained of either the place where the flap of the skin

was laid on the fascia, or the means by which they were united. It was not possible to distinguish the relation which these parts held to each other from that which naturally exists between subcutaneous fat and the fascia beneath it." "With the most careful microscopic examination, I could discover no lymph or exudation-corpuscles." Now, had there been a layer of organized fibrin between the surfaces, it could not possibly have been, in so short a time, so completely removed. We are by this case enabled to infer that two clean-cut surfaces, although foreign to each other, may also be united by immediate adhesion.

When, however, the essentials, one or more, for immediate union, are absent, then the fibrin, being required, forms a coating upon the surfaces of the wound, the serum having trickled away. Under these circumstances, the wound having been closed, the glazed surfaces are brought in contact and glued, as it were, together; and thus, union *by adhesion*, or *primary adhesion*, or *mediate union*, as it may be called, will ensue. The interposed bond of union may be thin, or it may be thicker, which will depend upon the degree of irritation attending the wound.

But sometimes the irritation of the part is so great, and of so long duration, that more fibrin is poured out upon the surfaces than can become organized, and degeneration of at least a portion sets in. Shortly, the wound will have a coating of pus, the interposition of which precludes the possibility of primary adhesion. But nature, in no way disconcerted, at once takes a different step. Although the wound may be gaping, and pus be flowing therefrom, yet beneath the pus is still a covering of lymph recently poured out. The irritation having ceased, this coating of fibrin assumes the work of repair. It is converted into *granulations*, by the successive layers of which the cavity may be expected to close. But this work of healing by granulation may be abbreviated, very often, by bringing the granulating surfaces together, and thus securing secondary adhesion, or what Hunter called union by second intention.

Healing by granulation, and subsequent secondary adhesion, may not only follow a wound, but also after destruction of tissue from inflammation, or from any other cause. (*Vide* Healthy Ulcer.)

Again: sometimes, when the part to be healed is limited and

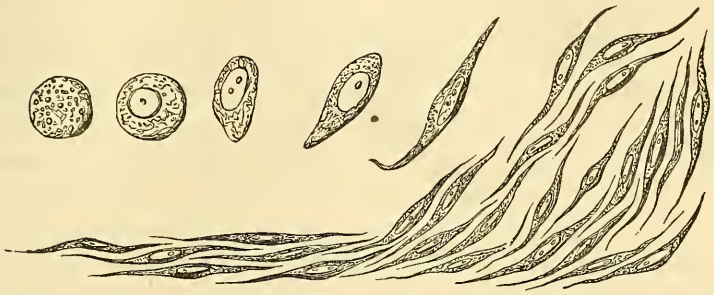
superficial, a portion of the fibrin upon the wound will, instead of degenerating into pus, become dry, so as to form a crust or scab. This crust serves to protect the part beneath from the air and other irritating substances, and thereby allows a quiet and rapid formation of a temporary structure, yet approaching in character to the natural structure. In this case, healing is procured by a species of growth which closely resembles the healing process in the cold-blooded animals. In order that this process may be carried on successfully, it is necessary that the serum of the liquor sanguinis should have a free way of escape, if it be not absorbed, through the superimposed scab; otherwise it will, by its presence and by the pressure, interrupt the healing process, and cause quick degeneration of the fibrin into pus, constituting an acute abscess. Familiar instances of this may often be seen when the skin has been torn off the hand, and a scab has formed.

In every one of the foregoing processes of healing, we have seen the fibrin acting a primary and principal part, and that it coagulates and becomes organized. It now becomes necessary to consider what is understood by this term; to understand to what extent fibrin can and does, under favorable circumstances, become an organized structure, and the manner in which it is accomplished.

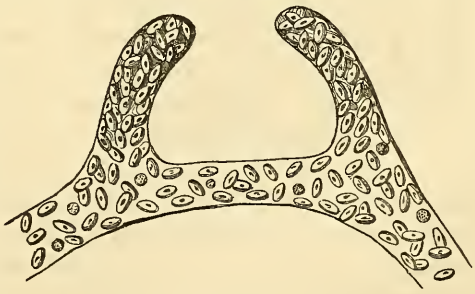
Organization of Fibrin.—The power of fibrin to become organized has, with a show of good reason, been disputed. But that it possesses a degree of vitality, there can be no doubt. It will be remembered that fibrin consists of two elements: a fibrinous, and a corpuscular element. Now, when fibrin separates from the blood and is placed upon the surface of a part about to be healed, we find certain changes taking place in the constituents. The corpuscles manifest a tendency to develop themselves—to grow. The shape becomes elongated, and sometimes they have a caudate form, or spheroidal shape. (Paget.) At the same time, the fibrinous portion exhibits a power to take on the form of fibrinous tissue, the cells being interspersed through the fibres. The degree of vitality shown by fibrin in thus coagulating will be found to vary.

It is necessary here to call to mind some facts dwelt upon in connection with the inflammatory process. Fibrin, when removed from the body, sooner or later shows a disposition to coagulate; and this is properly considered the last act of life. It is truly the

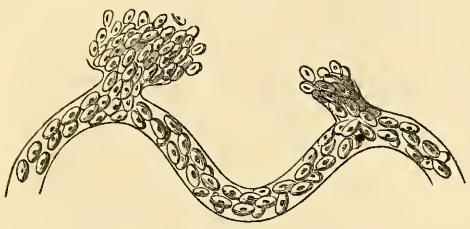
"*rigor mortis*" of the blood. (Simon.) Now, when the same takes place in the fibrin upon a wound, it is also, to a certain extent, the last act of life—so far, at least, as the fibrin itself is



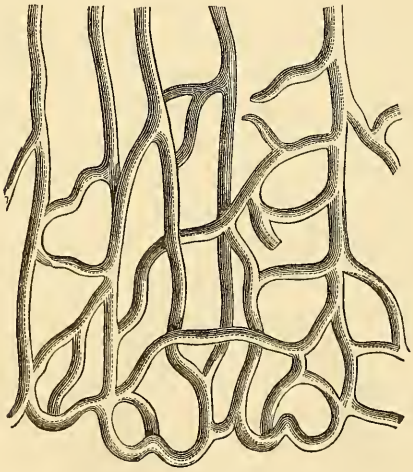
concerned; and were it not that the solidifying fibrin receives supplies of vitality from another source, death and disintegration would very soon ensue. But in the successful accomplishment of the healing process, it does obtain support from another source, which source is the blood itself. To have a supply of blood to the adventitious matter, it is necessary to have bloodvessels in the structure, by which the blood may circulate. It is necessary here to again call to mind the fact, that in active congestion the vessels become elongated and sacculated; and that when inflammation follows, those sacculated portions increase, until they are prolongations, and finally offshoots. (*Vide* diagrams.) It is a process similar to this by which the fibrinous glazing upon the surface of the wound, as it is coagulating, is provided with bloodvessels. These capillary offshoots reach here and there into the coagulating substance, and finally unite together to constitute a network, as in the natural tissue. Thus it is that the bond of union between the surfaces of a wound is supplied with blood, by which vitality is



sustained in the adventitious matter—the temporary structure; and by which the permanent tissue is to be built up. The same process takes place as well in other forms of healing, whether in secondary adhesion or in granulation. Wherever the fibrin is effused, there will be exhibited the same phenomena. The vessels are seemingly always formed in the same way.



Now, the adventitious matter, thus provided with bloodvessels, becomes thereby elevated toward the standard of true tissue; yet it is in one respect essentially and distinctly below it. It is wanting, at least, in one grand characteristic of the natural tissues of the body: it cannot assimilate to itself elements from the blood, by which its existence shall be perpetuated. The natural tissues, as we have learned, enjoy the power of begetting tissue like unto themselves, by which ordinary repair is constantly made, and, notwithstanding the wear and tear, by which the integrity of the part is steadily maintained. But this pseudo-tissue has no such power; at least, if it has, it is in the most limited degree. It therefore follows that this new substance is doomed to perish; that its constituent elements, as they die one after another, having lived their period of life, leave no similar elements to take their place. In other words, there is not nutrition of the adventitious tissue. While it resembles ordinary tissue in being subject to wear and tear, it cannot perpetuate itself. Particle after particle perishes,



and is removed by the absorbents, until in the lapse of time it entirely disappears. And while this want of power to beget tissue is manifested in the pseudo-tissue, the natural tissue, in which it is placed, displays that power to an exalted degree; so that, as the false perishes and is removed, the true takes its place. In this way, the substance which, for a time, occupied the place of natural tissue, is gradually removed by nature, and the natural tissue is as gradually restored.

In some cases, the process is carried on very slowly. Much will depend upon the age of the individual. The younger he is, the more rapidly will the work be accomplished. Even a large cicatrix is sometimes gradually removed in the young. At first prominent and unseemly, it, as months and years roll away, perceptibly diminishes, until finally it fades. Sometimes the scar is so large that a lifetime is not sufficient to effect the extinction; yet it is ever decreasing.

Healthy Ulcer.—In many cases, the fibrin is thrown out so rapidly, and in such large quantities, that it fails to become organized. It coagulates, but bloodvessels are not formed within it, and consequently its existence must be a brief one. It will very soon degenerate, or actually perish. More generally, the irritation leads to this effusion, and it, failing to organize, degenerates into pus. Under circumstances favorable to healing, the whole of the effused fibrin will not degenerate into pus; while the outer portion will thus degenerate, that which is immediately upon the tissue may be undergoing development. Not unfrequently, the irritation which led to the large quantity of effusion was the air, or perhaps other substances, coming in contact with the wound. In such cases, the *pus* becomes an assistant in effecting repair. It constitutes a covering, by which the air and other irritating substances are kept from the sensitive healing surface.

Under the covering of the bland pus is a layer of fibrin, undergoing changes similar to those which we have traced in adhesion. The fibrin coagulates and contracts; but it will be found that it does not evenly cover the surface. In contracting, it has taken place toward many centres, so as to give rise to little elevations, with intervening depressions. In this way are formed *granulations.*

Into each of these little bodies will soon be extended capillary

vessels; and in a short time, veins, and arteries, and nerves are developed. The presence of nerves has never been discovered; yet the extreme sensitiveness with which they are endowed indicates the existence of nerve-matter. Certainly, they are under the influence of the nerves, although one may not actually exist in the granulation.

The phenomena of life is exhibited in granulations. They grow, undergo gradual development, and, having reached a certain standard, they become the base for a second layer of granulations, which will be formed in the same way and developed by the same means, to be followed by successive layers. Thus, in time, the breach is entirely filled. As each successive layer is formed, its area is somewhat diminished, so that, as the healing sore comes to the surface, it is gradually lessening in diameter. This is due to a general contraction at the base of the ulcer as the healing progresses. There are a variety of circumstances which may modify the healthy granulation, and shorten or lengthen the time necessary for its accomplishment.

Cicatrization.—As, in the process of granulation, the surface of the sore approaches to a level of the integument, *cicatrization* commences. At the margin of the sore will be seen a bluish-white pellicle, gradually extending toward the centre. It is gradually developed into a pseudo-integument, to be in the course of time replaced by the natural. This cicatrization always commences and progresses from the circumference to the centre, until the whole of the granulating surface is covered, when cicatrization is complete. However large the sore, the process is always the same. Sometimes the covering will be seen to be simultaneously forming, from one or more points, islands in the central part of the sore; but it will be found, upon close examination, that in these places had been minute portions of the original skin, from which cicatrization could commence.

Essentials for Healing.—That the healing by granulation may commence and be consummated, it is necessary that there be not undue irritation. Inflammatory action must have entirely ceased. It has been shown, that in a given case of wound, a slight increase of irritation may completely arrest the union by adhesion, and render necessary the more complicated process of healing by granulation. Now, a still greater degree of irritation will disturb

the process, so that healing cannot at all take place, and perhaps convert the part into a state of ulcerative inflammation. It is therefore essential that every cause of inflammation should be removed; that the blood in the system and in the part should be in a physiological condition. The part, at least, should be steadfastly retained in a state of *rest*, the air and other irritants entirely excluded, and the circulation of blood quite normal.

Sometimes the above requirements, however, are not met. Nature may be unable to do the work of repair, and healing does not proceed. In other words, there may be a *disease* of the *healing process*, presenting to the surgeon some one of the many forms of ulcers, or sores, which he is called upon to treat.

CHAPTER XXII.

Ulcers—Diseases of Healing Process—Division of Ulcers—Causes of Unhealthy Ulcer—Constitutional Causes—Treatment of Healthy Ulcer—Of Unhealthy—Weak—Indolent—Irritable—Inflamed—Phagedenic—Cancer.

ULCERS.—*Diseases of the Healing Process.*—Ulcers may be divided into two general kinds, the *healthy* and the *unhealthy*.

In the *healthy* ulcer, repair is effected, under the rules of healthy action, by granulation, the process described in the preceding chapter. The time occupied is not prolonged; the part, when repaired, is stable.

The *unhealthy* ulcer is one in which restoration fails to be accomplished in the proper time, and in a stable manner.

Causes of Unhealthy Ulcers.—The cause of failure to heal may exist in the constitution, or it may reside only in the part.

Local Causes.—I will speak first of the latter, where, owing to local circumstances, the healing does not progress as in a state of health, although the blood may be healthy. It may be some irritation which leads to excessive determination of blood, and inflammatory action. Perhaps there is not the necessary *state of rest*. The part whereupon the ulcer is situated is made to move, as upon a limb; or, as often is seen, the function of the part keeps up as

much motion as will prevent the healing process. (*Vide* Fistulæ.) *Improper position of the part*, by which free circulation of the blood in the part is more or less interrupted, tending to *venous congestion*. The venous blood, which fills the dilated capillaries, cannot supply the elements necessary for healing. *Improper dressing to the wound* is another frequent cause of delay in healing, very often converting a healthy sore into an unhealthy one. It is so very difficult to disseminate the true and simple principles upon which the process of healing is based, not only among the public generally, but also among the members of the profession; and the fault, it must be admitted, lies at the door of the writers and teachers of surgery. If it could be fully understood that healing is alone the work of nature, and that to do her work she only asks to be let alone, and not to have the part placed in a state unlike the natural. Calling to mind the old but beautiful quotation, that "nature when unadorned is adorned the most," I would apply it here by saying that when a part to be healed is in a state of health, nature is most assisted when let alone.

A healthy sore requires nothing but protection from the air and other objects of irritation, and to be kept moist and clean. Yet often will numerous bandages be applied, and the part will become heated and irritated by the discharge, which is not allowed to escape. There is always, in healthy granulation, more or less of serum escaping; and this, pent up in the heated bandage, undergoes decomposition, forming a further source of irritation. Cleanliness, so important a consideration, is impossible under such circumstances. Again, the application of ointments to healthy sores is a very common thing. Occasionally, pure lard may protect a sore from irritation; but it is absolutely necessary to thoroughly remove it by soap and water once a day, otherwise it is sure to become an irritant. Often the lard, or the simple cerate, is impure, and, almost from the first, causes irritation. But even when it is not impure, it soon becomes admixed with the discharge from the sore, and very likely leads to chemical combinations which prove highly irritating to the sore and the tissue around. Although now and then unguents may serve to protect the sore, they should be strictly confined to the sore itself; for if the integument around is besmeared, it will be impaired in respect to function, and will not constitute a sound base from which shall grow and develop

the granulations. Again, a healthy sore may become unhealthy from *inherent weakness of the part* whereon it is located; or the part may become diseased from the *contact* of *some morbid material*, in consequence of which the tissue which forms the base is incapable of supplying, by assimilation, those elements from the blood which are required for repair and the gradual substitution of natural tissue.

A healing sore *may be converted into an abscess*, from the formation of an impervious crust over the surface which confines the serum of the liquor sanguinis that would trickle away. Its presence very soon arrests the healing, and undoes all that had been done. And again, a *healthy sore is sometimes changed into an inflammatory one*, by the presence of the trunk of a nerve upon its surface, or very near to it. It may be, numerous periphery nerves are involved. The consequence is, very great irritation, and inflammatory action of a persisting kind.

Constitutional Causes of Disease in the Healing Process.—Such diseases as vitiate either the tissues or the blood will often interfere with healthy healing. Any general weakness, hereditary or acquired—an impoverished condition of the blood, due to irregular living or bad food—may suffice. The constitution deranged from any cause, if a solution of continuity occurs, from injury, or inflammation, or destruction, the process of healing cannot ensue; or if it do, the work will be but slowly and imperfectly performed. Again, there are certain diatheses, which not only give character to ulcers, but are also frequently the cause of the ulcer. As has been elsewhere explained, tuberculous deposit and syphilitic poison often give rise to sores which are stamped in character by the cause. After the local manifestation of the disease, an attempt is made to repair; but, the blood being deficient in vital force, the effort will prove unavailing so long as the constitutional disease continues.

There are a variety of ulcers which the surgeon has to treat, the names of which indicate one or more of the causes, local and general. Thus, we have the *weak*, *indolent*, *irritable*, *inflammatory*, *scrofulous*, *syphilitic*, *sloughing*, *phagedenic*, *cancerous*.

Treatment of Ulcers.—The indications in the treatment of ulcers are very simple. The healthy sore, as before said, requires nothing besides *protection* from irritating substances, and atten-

tion to *cleanliness*, with continued *rest*. Simple water-dressing is the best application. The water should be neither hot nor cold. A fold of cotton, dipped in tepid water and gently applied, is sufficient to protect the part; that is to say, the cloth preserves the covering of pus upon the sore, which is the *natural protection*. And this pus *should never be removed*. The sore must be kept clean; but by this is meant the integument around the ulcer. The pus must never be wiped off the granulating surface, as may be often seen done.

The constitution is not in any way affected, and therefore requires no attention; unless it be to preserve the strength, under increased demands upon it.

Treatment of Unhealthy Ulcers.—The first thing is to possess a distinct knowledge of the cause; to comprehend exactly why the ulcer does not heal; whether the cause is local or constitutional, or both. Then let the surgeon's efforts be directed to effect its removal.

A sore that is filthy, and irritated from bandages and retained discharge, ought to be thoroughly cleaned with Castile soap and water, to be repeated at least once a day: an advice which it might seem superfluous to give; but, on the part of many, there is such a forgetfulness with regard to this, or an antipathy to it, that it is very often, according to my own experience, neglected. The bandages should not be used a second time, but burned when removed. The part must be kept in a state of rest, and in such a position as will allow free circulation of blood. Attention to position will be more important when there is a tendency to *venous congestion*, and, as a consequence of it, a weak or indolent sore. In the *weak ulcer*, where the veins are dilated, decided benefit will often be derived from the use of adhesive straps and bandages, by which external support is given to the vessels, and thus arterial circulation be favored. This is the great desideratum in the *weak* sore: to procure pure blood; to have it circulating freely in the part. If the blood itself is deficient in vitality, of course constitutional remedies will be required; but when the paucity of blood is due to local causes, those alone will demand attention. In the weak sore, there is not only a want of power to heal, but, there being an effort to repair, the result of the effort is the formation of granulations which are destitute of vitality. They are

pale and tall, instead of that florid and firm appearance characteristic of the healthy. The sore is perhaps more than filled with these overgrown granulations, which are elevated above the integument. If touched, they are found to be quite destitute of sensation, and are soft and yielding. The probe will easily break them down, and therefrom venous blood will freely escape. Now, very often these imperfect granulations cannot be developed into enduring tissue; and in many cases, when it is accomplished, a long time will be required for the purpose. Consequently, it is often necessary to destroy the mushroom growth—this which is often called "proud flesh." The effort may be made to bring the granulations into a healthy condition, by position, bandages, and stimulants; but this failing, it will be necessary to destroy them by caustic, generally the Nitras Argenti. A variety of stimulating applications have been recommended, in the form of lotion and ointment. The objection to unguents, before advanced, is perhaps even more decided here than in the healthy. I must offer my opinion, that when it is necessary to apply medicines, it is better to use them in the form of lotions. In addition to the lotions commonly in use, I have to mention one particularly, which I have found exceedingly useful. It is a lotion of belladonna, formed by water and the extract. In some cases of obstinate weak and indolent ulcers of the leg, I have succeeded in healing the sore, after everything else had failed. The lotion was applied in the morning, and then a bandage applied to the limb. When the caustic is resorted to, it must be used sufficiently to destroy the whole of the morbid growth. Often, after the caustic, a poultice will be required to assist the process of separation of the eschar. This being accomplished, it may be expected that healthy healing will commence from the bottom of the sore. Of course, the cause of the previous weak granulations must have been removed. The blood must be in a normal state, and properly supplied to the part. Now and then a poultice, applied at night, will promote the change from unhealthy to healthy; but as a general thing, it is *not only unnecessary, but hurtful.*

The *indolent ulcer* requires nearly the same treatment as the weak. It is characterized by a want of granulations generally, and sometimes it will be seen gradually extending, by ulceration, along the surface. Often it will remain in the same condition

week after week, with little or no variation. The bottom of the sore will present a coating of an ashy hue, which will have little or no sensation. Sometimes it will be sensitive in places. The margin is of a pale blue color, and often inverted, making the sore look as if the skin had been cut out with a stamp. This sore requires the same treatment as the weak kind, with this difference: that in the indolent, stimulating applications are more frequently of service than the caustic. There are no sickly granulations to be destroyed; but sometimes it is necessary to destroy the base of the ulcer, the tissue being so morbid in its nature as to be incapable of begetting any granulation at all. It is in this kind of ulcer that I have used to advantage the lotion of belladonna. Sometimes, in the leg, just above the ankle, the integument around the sore is altered in character. Its color is of a brownish red; somewhat shrunken, yet smooth and glistening. The skin thus affected may extend around the whole limb. The part probably has been in that state for years, and, if injured, is incapable of healing. It is exceedingly difficult to restore it to its natural state. Although the sore is made to heal, the skin obstinately remains the same, and the sores are liable to return. Attention to the general health, and avoidance of whiskey—which is a common cause of the affection—and also attention to cleanliness of the part, may after a time do much to restore the part to health.

The *irritable ulcer* is distressing. It is caused either by some irritating application, or by the presence of nerves upon the surface of the sore. The periphery of the nerves, morbidly sensitive, keep up an inordinate flow of blood, which is inimical to the healing process. The nerves can be easily detected by passing the probe gently over the surface of the sore. If there be scattered over it the periphery of the nerves, it will be tender to the touch in every part; and if it be the trunk of a single nerve, when the probe comes to it there will be a sudden flinching by the patient. The only way to effect a cure is to preserve the part from irritating applications, and apply something to soothe. Oftentimes cold water is the best. When there is a nerve, or there are numerous little ones distributed over the part, they must be destroyed. When the nerves are not large, a solution of Nitras Argenti may be sufficient, or the solid stick may be necessary. But when there is a single trunk causing the irritation, Hilton recommends the

use of a tenotomy knife, to divide the trunk a short distance from the ulcer.

The *inflamed ulcer* is the irritable intensified. It is more frequently due to some irritating application, perhaps the continued contact of a rough substance upon which the discharge has been allowed to remain. Conjointly, the blood is often in a gross state from imperfect food or intemperance. In the first place, the inflammation must be allayed. To do this, a lead lotion will prove the most useful. Afterwards, the treatment will be the same as that recommended for the irritable.

The *scrofulous ulcer*, the *syphilitic*, and the *sloughing*, have been fully considered elsewhere. (*Vide* those subjects respectively.)

The Phagedenic Ulcer.—This, of all the *sores*, is the most properly called *ulcer*, as it is marked by disposition to eat the neighboring tissue. There is, instead of healing, or an attempt to heal, destruction of the parts around, by rapid molecular death. There are two prominent causes. 1st. The constitution is commonly in a very depraved state, from privation, exposure, intemperance, and filth. 2d. Some poison, animal generally, often syphilitic, comes in contact with a part, perhaps the penis, and the determination of blood which ensues is only to hurry on the tendency to disintegration. The treatment is the same as for sloughing.

Cancerous Ulcer, or Cancer.—To properly consider this kind of ulcer, it will be necessary to investigate the general disease of which it is but a local manifestation. The sore which results from a cancerous deposit can scarcely be looked upon as an attempt to heal, but rather as an effort to eliminate a blood poison. (Simon.) The subject more properly belongs to the subject of *tumors*.

In conclusion, it must never be forgotten that these several forms of ulcer are unsuccessful efforts to heal; that they are truly diseases of that process; and while it will become the duty of the surgeon to restore the part and the constitution to a state of health, he must not be unnecessarily meddlesome. He cannot heal; it is only within his power to supply certain conditions necessary therefor.

DIVISION III.

EXTERNAL INJURIES—CONTUSIONS AND WOUNDS.

CHAPTER XXIII.

Contusions—Results—Treatment.

CONTUSION.—By this is understood a bruising of tissue, produced by a blow, or a fall, or a weight upon the part injured. The effect upon the tissue may be very slight, or it may be so great as to actually crush out the vitality. The part, in the former instance, will quickly recover its vitality; in the latter, it will become speedily gangrenous. Then, conditions ranging between the two may be followed by inflammation, ulceration, or sloughing. The degree of injury will not depend altogether upon the degree of force with which the foreign body comes in contact with the tissue, but as well upon the nature of the part involved. When a part struck is soft and yielding, other things being equal, the tissue will not be so much injured as when a subjacent bony structure exists, against which it will be more easily crushed.

The coats of the vessels, especially the capillaries, are more or less injured, and a rapid transudation takes place from them. This fluid consists of serum, fibrin, and the coloring matter of the blood. The corpuscles, many of them, are broken down; or perhaps the coats are so lacerated that a whole corpuscle can pass through the coat. It is this effusion, taking place so quickly, which gives that characteristic appearance called ecchymosis. If the tissue be lax, the effusion is greater; as, for instance, when a blow is received upon the eye. In this case, the lax tissue around the eye-socket is crushed against the bone, and thereupon we have the immediate disagreeable discoloration. Consequently, the degree of transudation will not depend upon the severity of the injury, but rather the laxity of the tissue.

The *symptoms* are always evident and characteristic. The *diagnosis* is not difficult; neither is the *prognosis*.

Results.—Discoloration.—This will persistently remain for a long time, as the coloring matter of the blood is not easily removed by the absorbents. When the vessels are torn, and pure blood is extravasated, the time will be very protracted before absorption is accomplished. The blood will in many cases coagulate, or partially coagulate. This is often seen at the circumference of the mass, while the central portion may remain in a fluid state. Under such circumstances, the part, if manipulated, will feel much as if there were an abscess—pus in the centre, and coagulated fibrin around. A clot of blood thus situated may remain for a lengthened period. It constitutes a foreign body, and, as such, may cause inflammation of the tissue rendered liable by the injury. The result may finally be suppuration, the formation of an abscess, and ultimate discharge. On the contrary, a species of organization may take place in the clot gradually, by which a tumor of a fibrous nature may be formed.

Treatment.—Will depend upon the extent of injury which the structures have sustained. The surgeon must diagnose, whether the part is much or but little injured; whether it will quickly recover its vitality, or more tardily; or whether it is doomed to perish. The steps pursued by nature must be the guide for the surgeon. A part injured beyond recovery will be duly detached and thrown off (*vide* Gangrene), and healing may be expected to follow.

In slight cases of contusion, unless upon an exposed part, but little requires to be done. When there is ecchymosis upon the face, especially about the eye, the patient will naturally be anxious, whatever the cause may have been, to have it speedily removed. It is by the absorbents that the work must be done. Above all, I have found useful the tincture of arnica. I do not say how it acts; but I have found that, when applied early after the injury, the discoloration is much prevented, and, I think, absorption much promoted. The tincture may be applied pure, or diluted with water. Afterwards, pressure made by collodion may do something to promote absorption. At a later stage, the tincture of iodine will be very useful as a stimulant.

Cold water may sometimes be used to advantage, but it must be

applied with extreme caution. The tissue, already very much impaired in vitality by the crushing, may easily be destroyed. Its use must be regulated by the heat and pain and redness in the part. If either or all of those be present, cold will be useful in preventing inflammation. Occasionally, sweet oil will, by softening the distended tissue, be of use; it will also soothe the irritated nerves. A poultice, applied cold, will now and then give sensible relief; but when the blood begins to flow inordinately through the part, cold astringents must be substituted. I have, while writing this, under my care a patient with a crushed hand. It was caused by being caught between two cars in the effort to couple them. The hand was caught sidewise. The metacarpal bones were all crowded and twisted together, and the hand actually burst open in the palm. The treatment has consisted in the diligent application of ice, rolled in cotton, and careful retention of the limb in a very elevated position. The result has been the most happy.

When extravasation has occurred, and a clot of blood exists which produces pain and is likely to cause inflammation, it may be expedient to made an incision. After a time, the clot may begin to soften, when the escape will be easy, and thus inflammation averted. When an abscess results, it will be treated on the ordinary principles. If sloughing or gangrene ensue, the treatment will be for such.

CHAPTER XXIV.

Wounds—Definition—Classification—The several Dangers attending Wounds—Incised Wounds—Characteristics—Gaping—Hemorrhage—Arterial—Natural Hæmostatics.

Wounds.—*Sudden Solution of Continuity.—Definition.*—An injury resulting from the disturbance of the physical continuity of tissue. The definition given by Cooper in his Surgical Dictionary, and which is generally more or less adhered to, is as follows: "A wound may be defined to be a recent solution of continuity in the soft parts, suddenly occasioned by external causes, and generally attended at first with hemorrhage." This definition is objection-

able; because there may be wounds of the bone and of the cartilage, as well as of the soft parts. For instance, a cutting instrument, as a sabre, may divide at once the scalp and the skull. Again, an axe may be buried into the leg, dividing not only the soft structures, but the bone as well. In these cases, the harder structures are wounded as well as the softer.

Another objection is, that other than external causes may produce wounds. Muscular contraction, suddenly taking place, may cause division of a tendon. A fragment of bone will often, in being displaced, cause a wound of the soft parts. These are internal causes of injuries, which may be as appropriately termed wounds as any others that can be adduced. Still again, a wound is often made by the surgeon, subcutaneously, for the purpose of dividing the tendon of a contracting muscle.

Classification of Wounds.—There are several divisions, each of which will be mentioned.

First.—A division based upon the character of the instrument or means by which the wound was inflicted; namely, *incised*, *lacerated*, *punctured*, *contused*, *gunshot*.

Second Division.—Into *specific* and *non-specific*.

Third Division.—Having reference to the region of the body in which the wound is located; as *wounds* of the *head*, of the *face*, of the *neck*, of the *thorax*, &c.

Fourth Division.—Into *simple* and *compound*.

Fifth Division.—Into *open* and *subcutaneous*. (Syst. Surg.)

Danger of Wounds.—Prognosis and Diagnosis.—In the first place, let us consider the degree of danger which may attend various wounds, and the source of the danger, bearing upon the *diagnosis* and *prognosis*. It will depend, in the first place, upon the *size of the wound*. The larger the wound, *cæteris paribus*, the greater the danger. 2d. The *degree of natural strength* of the *part wounded*, by which a shock may be endured, or from want of which a severe shock may be experienced; that is to say, a high degree of nervous endowment, or an absence of such. 3d. When a *part may be weak*, in consequence of the small supply of blood given to the part; this may preclude the hope of a quick or perfect repair. 4th. The danger will depend upon the *importance of the structure involved*. Thus, when an organ *necessary to life* is wounded, as the heart, or the lung, the danger is imminent.

Again, a wound of the throat is critical, because of the necessity of using the part for breathing and deglutition. 5th. Another source of danger is *when a large bloodvessel is divided.* If the vessel be large, death may be the immediate consequence; or if the loss of blood be very great, the evil effects may be lasting. 6th. The *kind of wound* modifies the danger. If a wound be bruised, or lacerated, or poisoned, the danger is much increased. When *a part* is, with the wound, affected in either of the above ways, nature will have more to do than simply to repair, as in the incised form; consequently, the danger is greater. 7th. The danger is greater when the *constitution* is suffering from any *morbid diathesis*, as the scrofulous and the syphilitic. 8th. In the aged, a wound is more likely to prove serious than in the young.

Immediate cause of death when it ensues.—When death ensues from the wound, it may be in *consequence of hemorrhage,* immediately taking place, or some time after. It may also be from an attack of *tetanus;* also of *erysipelas*, or *pyemia.* It should be remembered that a healthy sore may be the channel by which erysipelatous poison, especially, may be introduced to the system, through the use of a contaminated sponge, or the unwashed hand of the nurse or surgeon. A sponge that has been in use ought never to be applied to a fresh wound. Again, death may be due to *hectic symptoms*, which, after a time, may supervene from continued discharge and irritation, in connection with loss of blood. Death may result from a *part becoming gangrenous.* The tissue around the wound may have been injured, and may subsequently die; or a part may have been cut off from the necessary supply of blood, by division of an artery.

In considering the subject of wounds, it will be convenient to take the first of the several classifications.

Incised Wound.—In a pure case of this kind, the tissue is simply divided by a sharp cutting instrument, the tissue around being entirely uninjured. The surface of the wound is neither lacerated nor bruised: it is barely irritated. The instrument had necessarily possessed a thin blade, as well as a sharp edge, and the least possible force would be sufficient to cause a solution of continuity. This is the simplest kind—the perfect type of an incised wound.

A wound may be small or large. It may be extensive super-

ficially, or deeply penetrating. Both the extent, and the direction in which the wound extends, will always be a primary consideration with the surgeon.

Characteristics of the incised wound, are *pain*, *gaping*, *hemorrhage*.

The pain experienced from an incised wound is of a smarting or stinging nature. It is caused by the exposure of the cut nerves to the air, the air to them being exceedingly irritating. The irritation may in part be due to the instrument itself by which the wound was inflicted. Principally, however, the pain results from the contact of air, or of foreign bodies. The more bountifully the tissue is supplied with nerves, the greater will be the pain.

Gaping is caused by the contraction of muscles, and by the natural contractile power with which tissue is possessed. Gaping is always present; but the degree will depend, not upon the contractile power alone, but principally upon the direction of the wound. The gaping is greater when the cut is crosswise of the muscle, and less where it is parallel with the fibres. The deeper the wound, the greater the gaping may be expected to be.

Hemorrhage may come from an artery, or vein, or from capillaries, or from several sources. A few or many vessels may be divided. The surgeon must distinguish between arterial and venous hemorrhage. It is not difficult to do so. Blood from the artery comes in spurts at each contraction of the heart and arteries—"*per saltum*." The arterial blood is of a bright red, being oxygenated. The venous blood, on the contrary, issues with a steady even flow, and presents a much darker hue.

Arterial Hemorrhage.—It will be advantageous to remember that in discussing this subject, we shall learn the nature of hemorrhage which attends various surgical operations, in the performance of which, the surgeon intentionally divides structures of the body, such as in the removal of tumors, and in amputations, and in excisions. Also we shall learn many of the principles relating to aneurisms. Arterial hemorrhage is the most dangerous form. If it come from several, or many smaller vessels, it will prove less difficult to control, than when it comes from a large vessel. Here, again, the surgeon, to properly comprehend what steps shall be taken to arrest the bleeding, must carefully examine the footsteps of nature—must learn of her who is an infallible teacher.

Natural Hæmostatics.—It is a fact, known by any observer, that in many cases, hemorrhage, which at first seemed fearful, will in a short time be effectually arrested by nature alone. The surgeon can but proffer assistance—can but order circumstances which will constitute, so to speak, a starting-point for natural operations. Any one who has seen the knife in the hand of the surgeon, dividing the tissues in the performance of an operation, will have observed that the blood at first came rushing copiously forth, but that it gradually lessened, until, in most cases, it entirely ceased to flow. One minute, it would seem to the uninitiated, that the patient was bleeding to death; at the next there would be barely an oozing. The mouths of the vessels from which the blood welled are quite closed. Now, by what means was this accomplished? How can we account for this phenomenon?

From careful investigation it is found that there are several important steps taken, one after the other, but in quick succession, the result of which is the stoppage of the bleeding. That contractility of tissue, by which gaping of the wound is produced, affects the arterial coats, in common with the other tissues. Under this irritation the coats both contract and retract. It is a rare thing to see fully exposed the open mouth of the vessel, although bright red blood marks the spot; and the reason is, that it is drawn in from the surface of the wound—the coats retract. The contraction of the coats will lessen the size of the vessel, and in very many cases completely close the mouth, and so arrest the hemorrhage. This is favored by the absence of that pressure from within, which is regularly made by the ever-passing stream of blood. Of course this contraction and retraction are principally due to the muscular coat by which the artery is drawn in from its sheath. The result of this combined action of contraction and retraction is that the lips of the open vessel are drawn in, making it seem as if the middle coat were contracted more than the external, and the internal more than the middle. The lips of the internal coat are in this way drawn towards each other, and in smaller vessels actually together, thereby stopping the flow of blood. When the coats are thus brought in contact they unite by adhesion, and thereby accomplish another step in the process of *natural hæmostatics*. But when the contraction is not sufficient to close the vessel completely, the object may be attained by

further aid, which nature, prolific in means, will be able to give. Remember that the vessel is drawn from its sheath, leaving a space which is quickly occupied by blood (with perhaps an excess of fibrin in it). This blood will soon begin to coagulate and contract, and this ring of coagulating blood will, in a certain number of cases, afford sufficient pressure from without to complete the work of closing the vessel. Sometimes the sheath is drawn away from the vessel by the contraction of the tissue around, in which case the space between it and the vessel is greater, and the quantity of blood to coagulate will be correspondingly greater. Not only will this clot form around the vessel, but it will manifest a tendency to extend over the mouth of the vessel; and, if the blood do not spurt out with too much force, this will be successfully done; and thus the artery will be sealed with a clot of blood which is quite external. But when the artery exceeds a certain size, the force of the wave of blood will be so great as to prevent the formation of the clot over the mouth, and the bleeding will continue. A certain length of time is always necessary to determine whether nature can accomplish the work or not. Here then are several means by which arterial hemorrhage is at first naturally arrested: First, there is contraction and retraction of the arterial coats, which tend to close the open vessel; then, the space between the vessel and sheath is occupied by coagulating blood, which by external pressure will further the process already commenced; finally, the clot of blood may gradually spread over the mouth from which the blood was spurting, and so form a complete seal. This is the first stage in the process of natural hæmostatics.

These steps, although admirable, are not lasting; yet they are of sufficient duration to enable other and permanent ones to be taken. When the lips of the inner coat are in contact, adhesion will take place between them; it is immediate union; but when the lips are not in contact their surfaces will be coated with fibrin, which, perhaps, will constitute a bond of union. When, however, the outer clot of blood is slowly formed, there will be, when the bleeding is finally arrested, a plug of fibrin formed in the orifice. Now, whatever may be the way by which the mouth of the vessel is closed there will immediately follow steps for organization in the fibrin. And, while this is being done the arterial tube will be

gradually filling with a fibrinous clot, which will separate from the blood coming to the part. This plug of fibrin will form along the tube as far as the first branch given off from it. It will fill the vessel at the point where it is divided, but will taper to a point, making the whole cone-like in shape. By means of this clot the hemorrhage is effectually and permanently arrested. In time, the clot of blood, which acted an important part primarily, is detached, and cast off; but the internal clot assumes the form of adventitious tissue, perfectly seals the wounded vessel, and, finally becoming amalgamated with the arterial coats, there remains but a cord-like substance. Thus we see that in natural hæmostatics *fibrin* is the necessary agent by which the action is completed. The clot in reality constitutes in the whole length, as far as it may extend, a bond of union to unite surfaces together. When it has served its purpose it will gradually decay, and be removed; and so will the arterial tissue in the process of time. This is the second and last stage in the process of hæmostatics.

In order that the above described procedure may be commenced and carried on, it is necessary that the artery be not too large—that the blood do not flow into the part with too much force; because the rushing blood will not allow coagulation to take place at the orifice. Under such circumstances, it will be for the surgeon to give the assistance which art places at his disposal. There are two things, generally, which may be done, or attempted, either to place something against the vessel as a substitute for the external clot, until the inner clot of fibrin can have formed; or to arrest or diminish the current of blood flowing to the part, with the object of allowing the external clot to form, which had been prevented by the force of the regular waves of blood. And this brings me to speak of the general indications in the treatment of incised wounds.

CHAPTER XXV.

Treatment—General Indications—To Arrest Hemorrhage—Cold Air—Cold Water—Pressure—Styptics—Escharotics—Nitrate of Silver—Ligature—Torsion—Acupressure—Constitutional Means—Of Secondary Hemorrhage—Of Venous Hemorrhage.

General Indications in the Treatment of Incised Wounds.—They are: 1. Arrest the hemorrhage. 2. Remove all foreign bodies from the wound. 3. Approximate and retain the sides of the wound in contact. 4. Keep the part at rest. 5. Prevent inflammation; or, should it arise, subdue it. 6. Protect the wound from external irritation.

To Arrest Hemorrhage.—In some cases, by keeping the wound exposed to the air, the irritation may be sufficient to effect the object. The colder the air, the more likely is it to cause contraction; and cold water applied will, in a large number of cases, very much increase the irritation. Perhaps there is no agent more generally useful, and certainly there is none more easily obtained, than cold water. It requires to be steadily applied, and with a uniform cold temperature, to the part. The water possesses equal virtue in hæmostatics to what it does in the treatment of inflammation. It is particularly necessary that the parts around the wound should have a continually low temperature; consequently, a cessation in its application will be followed by reaction, and the blood, rushing into the part, may force away the external clot of blood before the inner clot of fibrin can have formed. The cold water may be applied by a fold of cotton cloth, frequently dipped in the water; or, in many cases, it may be used by arranging a temporary syphon, so as to allow the water to fall, drop by drop, upon the part. The water ought to be ice-cold. It must not be forgotten that the object aimed at is to prevent reaction, for therein the danger consists.

Pressure.—Another method, frequently adopted, is to make pressure, either against the open mouth (direct pressure), or upon the artery above, where, in its course, it can be conveniently

made (indirect pressure). The most speedy way in which pressure may be made, is by the hand. The finger may be thrust into the wound—as it often is, by the operating surgeon, when a gush of blood interrupts the proceedings—and be placed directly upon the vessel, the warm gushing blood being his guide. Oftentimes, the surgeon will be sent for, in hot haste, to visit one who has been seriously wounded—at least, the bleeding is frightful. The surgeon will, in such cases, be called upon to display his presence of mind, where all is confusion; and his skill, when all eyes are turned to him. Numerous bandages will, no doubt, have been applied, and the bleeding may have ceased; but the bandages, in every case, will have to be removed, that the vessel or vessels may be properly secured. If there be no bleeding, all arrangements should be made before the bandages are touched; but should the arterial blood be seen streaming through them, then the proper course is to use promptly indirect pressure, if it be possible; or to tear the bandages away, and control the bleeding at the vessel's mouth. The flow of blood arrested temporarily, the surgeon can consider what further assistance or instruments he shall require. Sometimes the exposure of the wound to the air, with the irritation and pressure of the finger, will prove sufficient to close the artery; or the pressure may have to be continued for a time. There are several ways of applying pressure; namely, by the hand, the compress, the roller, the tourniquet.

There are several kinds of compress, which may be applied in various ways. Very often it is composed of a roll of cotton, or several layers of cotton. The compress may be put directly upon the bleeding part, or it may be indirectly applied. The compress properly adjusted, the pressure may be made by a bandage passed around the limb or body with sufficient tightness; or adhesive straps may be employed instead. When direct pressure is continued for a time, it is in reality intended to take the place of the external clot of blood, which would form at the mouth did not the current of blood constantly force it away; the pressure should therefore be continued until the inner clot of fibrin can have formed. And it will be understood that the pressure requisite will be just so much as may be necessary to overcome the force with which the blood comes to the part.

There is a danger, into which I have seen many surgeons fall,

of having the pressure too great, and of continuing it too long a time. It is an incised wound; and although the desirability of obtaining union by adhesion is important, it is nevertheless quite sunk in the more important one of arresting the hemorrhage. But, at the same time, no unnecesary hindrance should be allowed to exist to the more speedy method of healing. Consequently, there should be no more irritation than is necessary; nor should the compress be allowed to act as a foreign body without reason. In every case, however, if there is an error, let it be on the side of undue care to arrest the hemorrhage. When the pressure is indirect, the object aimed at is to diminish the force of the arterial current, so that a clot may form. More than this is unnecessary, yet not particularly injurious. For further remarks on *indirect pressure—tourniquet—vide* Aneurisms.

Styptics, or astringents, is the next class of remedies to be mentioned. A styptic may act by contracting or constraining the tissue, and thus closing the vessel; or, it may be, by inducing coagulation of blood; or it may act simultaneously in both ways. Cold water is commonly included among this class. A most valuable medicine of this class is the sugar of lead. It acts chemically upon the blood, causing it to solidify very quickly. It may be administered internally, and is often thus used in uterine hemorrhage; and it may be applied directly to a bleeding part, by a piece of cotton saturated in the lotion. There are a variety of vegetable astringents which may be employed, but it is unnecessary to enumerate them. I mention only one more astringent—the Tinct. Ferri—which I have seen arrest bleeding when other means had failed. Styptics may be used in conjunction with pressure, or other remedial measures. The puff-ball, a common domestic remedy, and a very useful one, may be mentioned here. It causes the blood to coagulate, by affording suitable material upon which the fluid may rest and the fibrin solidify.

Escharotics claim a place among the agents which the profession use to arrest hemorrhage. It is not so commonly resorted to now as in the days of barbarism, yet even now it is used by some, and with success; but it should not be employed when a less painful and startling remedy can be used. A heated iron applied to the bleeding part forms a charred covering; the arterial tissue, with that around, is destroyed, and at the same time dried up; thereby

the vessel is temporarily closed; there is formed a substitute for the external clot, and thereafter the internal clot may be able to form. But, inasmuch as the eschar will have to separate from the living tissue by a process of suppuration, there will always be a doubt whether the fibrinous plug will become affected, and degenerate so as to open again the mouth of the vessel; but, in many cases, the fibrin will be sufficiently organized to resist the influence of suppuration. The cautery should be heated to white heat, so that it will completely dry up the tissue, and, consequently, there will be less of suppuration as the eschar becomes detached, and the danger of secondary hemorrhage will not be so great.

Nitrate of silver, as a potential cautery, is of great utility. It seems to act in two ways: first, by drying up the tissue, and thereby closing the vessel; secondly, by inducing coagulation. It may be used to advantage in small wounds, where union by adhesion cannot be expected.

The *ligature* is an agent for the arrest of hemorrhage, which demands a somewhat extended notice. It is as useful as it is old. Different kinds of ligature have, from time to time, been employed by the profession. The changes which have taken place have related to the material of which it was made, and to its shape and size. To give a history of the ligature, although interesting, would not be of sufficient practical use to warrant its introduction here. The round ligature, made of well-twisted silk, somewhat waxed, is the one now very generally used. The celebrated Hunter used a flat and somewhat broad ligature. The principles upon which this practice was based were erroneous, namely, that if the surfaces of the inner coat were brought together and there retained, union by adhesion would result, and the danger of suppuration within the vessel would be averted,—such as attends the division of an artery, and the subsequent sequestration of the ligature. He particularly aimed to *avoid a division of the coats*, and employed a ligature broad and flat, that the surfaces might be pressed together without dividing the tissue. But, unfortunately for this theory, it is impossible to apply a broad ligature without extensive detachment of the artery from its sheath, which would necessarily give rise to considerable irritation. And, more than that, the arterial tissue would be deprived of its nutritious supply by this separation of the sheath. Irritation, inflammation, and

suppuration, will necessarily follow outside the artery, and the process of adhesion within be thereby thwarted.

This practice was pursued by Hunter in connection with aneurisms, where he wished to ligate the vessel some distance on the cardiac side.

The theory now held, and which may be considered a true one, as it has stood the test of many, many years, is that a ligature should be applied with as little irritation to the tissue as is possible; and that every care should be taken to preserve the nutritious vessels. Another essential point in the theory is, that the internal and middle coats should be divided. To secure the above indications the round ligature is employed. The surgeon divides no more of the tissue with the knife, than is necessary to reach the artery; and then, with the greatest care and gentleness, passes the tenaculum around it. Finally, the ligature is tied around the vessel with sufficient firmness to divide the coats within, which the surgeon can know by feeling a yielding sensation, while the external coat remains unbroken. The coats within, immediately upon being divided, contract and retract, so that they are drawn some distance from the seat of the ligature. Herein seems to consist the safety of the operation. That portion of the external coat which is embraced by the ligature, is doomed to destruction; and the work of its sequestration will be attended by ulcerative inflammation. But, if the ligature has been applied with but little irritation, the inner coats having retracted from the place where that irritation exists, the formation of a clot of fibrin will duly take place, which will not be exposed by the subsequent ulceration and separation of the ligature, unless it should be considerable. In favorable cases the pus formed may be measured by drops. The advantages of the round ligature, it will be seen, are twofold; it can be more easily applied, and by being tightly applied it divides the internal coats so that they retract from the place of irritation, where a permanent plug of fibrin is allowed to form.

The ligature may be used to the open vessel in the wound, or the main artery on the cardiac side may have to be taken up. The operation for cutting down upon an artery for its ligation may be referred to in the treatment of aneurisms. With regard to tying a vessel in a wound the surgeon should remember, in using the forceps or tenaculum, to make as little traction as possible.

The artery should be only raised sufficiently to allow the application of the ligature. And when tying the knot, care must be taken to so hold the ligature that the vessel will not be disturbed in its bed. This is essential, that the sheath may not be separated. It is always desirable that only the arterial tissue shall be inclosed in the ligature; but sometimes it will be so contracted, that some of the tissue around will necessarily be included in the mass. The larger the mass the greater will necessarily be the ulceration, destruction, and obstacle to union by adhesion. After tying the knot, one end will be cut off, while the other will be allowed to remain hanging from a corner of the wound, so that it may be removed from the wound when it has separated by ulceration from the artery. The requisite time, for this work of nature, will depend upon the size of the artery and some other circumstances. The time given by most authorities varies from ten to twenty days, with the average being fifteen days.

The existence of this ligature in a wound may be the only bar to a speedy union by adhesion, and the surgeon may be tempted to try at an early date to extract it. Any such procedure is attended with great danger of secondary hemorrhage. It is necessary to wait until the ligature is in all probability sequestrated. In removing it no force should be used whatever. The surgeon should make the very least degree of traction, and should it at once yield, it is well; but if there be the slightest holding, he must at once desist. The danger consists in this: if the artery be disturbed before the inner plug is firmly established, it may be dislodged, and thereby the vessel be opened. From time to time the trial may be repeated until it is found to be separated. I have in mind a case where, after amputation at the shoulder-joint, an injudicious effort was made to extract the main ligature. In a few hours after, alarming hemorrhage came on; the result was, that the wound had to be opened and the artery tied again.

Occasionally the ligature, although quite detached, will be held somewhat firmly by the granulations. This can only be inferred, after a long time has elapsed.

Torsion consists in seizing the divided artery, and drawing it slightly from the sheath, and then so twist it as to crush and lacerate the coats. By referring to lacerated and contused wounds, it will be seen that in them the hemorrhage is not so great as in the

incised. The irritation of laceration causes a greater contraction of the coats, and when they are bruised the ragged tissue favors coagulation of the blood.

Sometimes the seizing of the vessel with the forceps, and holding it for a moment, will prove sufficient to arrest bleeding.

Acupressure.—Another agent yet to be noticed, is a form of direct pressure. It is not as yet in general use; but is, no doubt, of great value. Dr. Simpson, of Edinburgh, has introduced it and commends it highly to the profession. Certainly the principles are most sound upon which the practice is based. In the amputation of a large limb the ligature which is applied to the principal artery will very materially interfere with healing by primary adhesion, and the process of sequestration of the ligature will for a long time delay a perfect recovery. In view of these facts it can be readily understood that if the ligature, the foreign body, could be removed this delay would not be so protracted. Now the ligature is tied around the artery to arrest the blood until the plug of fibrin has formed within; after this has been accomplished, it is no longer required; but there it must remain until the process of separation by ulcerative inflammation is accomplished. This, however, endangers the integrity of the inner clot. Could, therefore, the ligature be untied, or divided so that it might be extracted, the process of recovery in the stump would be hastened, and secondary hemorrhage averted. Dr. Simpson proposes to substitute for the ligature, a substance that may at any time be taken away; and which, while in the wound, is even less irritating than the ligature. A pin, of suitable size, is passed from the integument of the flap in which the artery is situated, and is then made to appear on the cut surface of the flap just beside the artery; it is now made to bridge over the mouth of the vessel, and to enter again the flap, and, finally, to reappear upon the surface of the skin. By this means pressure is made upon the vessel, while the vitality of the arterial coats is not at all jeopardized. When the artery has become permanently sealed by fibrin within, the pin can be extracted, and nothing remains to interfere with the quick and permanent work of repair by adhesion.

Not having had an opportunity of testing the practicability of this procedure, I can only say that the principles are such as commend themselves to the reflecting surgeon. Indeed, I can

hardly think that Professor Simpson (whose kindness to me, while in Edinburgh, I remember with gratitude), who enjoys a world-wide reputation, could be led astray by anything doubtful.

I have now noticed the most important remedies for local use in the treatment of hemorrhage, every one of which is used with strict attention to the way in which nature travels to do the same thing. They are all designed to *aid in the process of natural hæmostatics.*

Constitutional Means to Arrest Hemorrhage.—It is often necessary to resort to constitutional measures to arrest bleeding from arteries; perhaps in connection with local treatment; perhaps when it is impossible to successfully employ local remedies. Here again let us study the operations of nature, that we may learn the true principles of constitutional treatment. The phenomena of *fainting* from loss of blood supplies us the necessary lesson.

Among other symptoms of fainting, is a very feeble pulse, indicating a diminished action of the heart, and a tardy flow of blood through the arterial system. Therefore it often follows, when the vessel is not large especially, that as soon as fainting occurs the bleeding ceases, and at all times the flow is diminished in force. Now, it not unfrequently happens that during the period of syncope, while the blood is flowing slowly and with little force, a clot will have opportunity to form in the orifice of the vessel, and with sufficient firmness to resist the volume of blood when it again comes in full force. While the blood flowed with natural force, this was impossible; but when it came with lessened speed, the tendency to form a coagulum prevailed, and thus the hemorrhage became arrested. From this fact it will be learned, that when a person faints from loss of blood, he should not be hurriedly restored to animation, but rather he ought to be allowed to remain in a state so favorable to natural hæmostatics, unless there should be danger of sinking. And when the patient does begin to recover, great care ought to be taken to have a gradual return to power of the heart; inasmuch as a sudden action of that organ may—indeed, is likely to—dislodge the clot which has formed. Stimulants ought not, therefore, to be given, unless reaction is doubtful.

From the above facts, we moreover learn that diminished action on the part of the heart, and the consequent tardier flow of blood,

is favorable to the arrest of bleeding. Now, in cases of wounds involving arteries which cannot be secured by ligature, as in the liver and lungs, the surgeon has to trust alone to constitutional measures. The importance of rest, both physiological and mechanical—of body and mind—must not be forgotten. An assurance to the patient, when such can be given, that his case is not alarming, will have a tranquillizing effect upon the mind, and thereby upon the heart; and perfect repose of the body, especially of the part where the wound exists, will materially conduce to the formation of the clot. For agents to control the action of the heart, and to secure repose, there particularly are antimony, veratrum viride, opium, digitalis. (*Vide* Treatment of Inflammation.)

Secondary Hemorrhage.—While speaking of arterial hemorrhage, allusion has been made to the fact that, after a time, the bleeding may recur—there may be *secondary* hemorrhage, the fibrinous clot within the vessel having been disturbed.

Causes of Secondary Hemorrhage.—May be divided into *local* and *general.*

Local Causes.—Are: 1. Inflammatory action, by which the internal clot, instead of becoming organized, is made to degenerate, thus opening the bleeding channel afresh. 2. Ulceration, perhaps in consequence of injury to the arterial tissue, at the time the wound was received. 3. Inconsiderate meddling with the ligature, before sequestration is completed.

General, or Constitutional Causes.—Are certain diseases of the blood, characterized by unnatural fluidity of its solid constituents. The fibrin is incapable of permanent coagulation; it exists for a time, but suddenly degenerates and disintegrates, and then secondary hemorrhage is the quick result.

Treatment.—The surgeon must prevent, so far as possible, all local causes, and watch for those which are likely to produce so unpleasant a complication. When the bleeding actually occurs, the same rules will be followed as are observed in primary hemorrhage. It will not unfrequently be necessary to cut down and tie the artery on the cardiac side.

Venous Hemorrhage.—This may easily be distinguished from the arterial. The blood, instead of coming in waves and with an impetus from the heart, flows in a more steady stream, from some

distal part, to the heart; and as it pours from the wound, it presents a much darker hue than the arterial. The coats of veins possess the power to contract, to a limited extent; but by no means so great as the arterial do. They are comparatively lax; and when the vein is empty, it is quite collapsed. The venous system is such, that if one channel is occluded, or otherwise becomes incapable of containing blood, the fluid may find other channels by which to pass on in its course. And, in a large number of cases, as soon as a wounded vein has emptied itself, the hemorrhage ceases, to a great extent, or altogether. In a certain number of other cases, temporary pressure by the finger upon the bleeding vessel will be sufficient to change the current into collateral branches. It would seem that, in most cases, the external pressure by which the vessel is collapsed is greater than that of the blood which was flowing through it; and thus the blood is prevented from entering the wounded vein. When a very large vein is cut into, the force of the passing blood may be so great as to prevent collapse of the vessel, when the hemorrhage will continue.

Treatment of Venous Hemorrhage.—Direct pressure is, by far, the most suitable agent. It is conveniently applied, and easily removed after it has served its purpose. As already said, temporary pressure by the finger may be sufficient to overcome the power of the venous current. When continued pressure is required, a compress, with a bandage or adhesive straps, will be demanded. It is decidedly opposed to surgical practice to apply a ligature to a vein, unless it be a large one. The fact that it is generally unnecessary, is a sufficient objection; but the more commonly recognized objection is the belief that such procedure is likely to cause either phlebitis or pyemia. It has been generally believed that the application of a ligature to venous tissue will lead to extensive suppurative inflammation, with the attending danger of the pus finding entrance into the circulating blood. In respect to this, however, perhaps the danger has been overrated. At all events, not a few cases have been recorded, in which no disastrous or unpleasant result followed the ligation of a vein. (*Vide* Pyemia.) A ligature, however, should never be used except when pressure fails to arrest the hemorrhage. As a general thing, it will require to be tied only on the distal side of the wound. Occasionally, a second one on the cardiac side will be required. The

subsequent treatment does not differ from that which is pursued after ligation of an artery. The same process of sequestration will have to take place.

When a larger vein is wounded, but *not divided*, it is recommended to avoid destroying the vessel by tying a ligature around the orifice, thereby closing the vein in the same way as a wound of the intestine would be closed.

Position is an important part of the treatment of venous hemorrhage, as by it alone the bleeding may sometimes be arrested, or, on the contrary, made to continue.

In connection with wounds of veins, a serious accident sometimes occurs, namely, *entrance of air.* (*Vide* Lesions of Veins.)

CHAPTER XXVI.

2d General Indication: Remove Foreign Bodies. 3d: Close the Wound and Retain—Means: Plasters—Sutures—Twisted Sutures—Quilled. 4th: Prevent Inflammation.

Removal of Foreign Bodies.—The *second indication in the treatment of wounds,*—to *remove foreign bodies.* These may be, possibly, a piece of the instrument that inflicted the wound; sand or dirt, or a bit of clothing, or a clot of blood.

The last-mentioned is as much a foreign body in its effects as either of the others. If large, it acts, as a writer has said, like a sponge in the wound; expanding and expanding, and very likely after awhile causing a recurrence of the bleeding; and still later, when it begins to disintegrate and perish, it constitutes a dead animal substance, which cannot be otherwise than exceedingly irritable and inimical to healing by adhesion. Therefore, if healing by primary adhesion is sought for, no clot whatever must be allowed to remain between the surfaces to be united, either at the surface or in the bottom of the wound.

In removing foreign bodies care must be taken to avoid irritating the tissue. A soft sponge with water will generally be

adequate to remove the clotted blood and dirt. Larger and firmer bodies can be extracted by the dressing forceps or the finger.

Foreign bodies having been completely removed, the surgeon is prepared to attend to the

Third indication in the treatment of wounds,—to *approximate* the opposed *surfaces of the wound* and *retain them immovably in contact.* It will be remembered that the separation, or gaping, is caused by the contraction of muscle, and the contractility of the tissue. These causes of gaping must be removed, or controlled. It is, therefore, of primary importance to relax those muscles by which the gaping is produced, and by every possible means beget a state of quietude, so as to prevent any twitching, or irregular action of muscular fibre. The first things to be attended to are *position* and *rest.* The agents, besides, to be used, are *bandages*, *compresses*, *adhesive straps*, and *sutures.*

Bandages prove serviceable in two ways: first, by giving support, as when applied around a limb; and, secondly, by controlling muscular action. The benefit to be derived by applying a bandage, from the extremity, along a limb to the wound, cannot be too highly esteemed. In large deep wounds a compress placed on either side of the wound, and bound there by the bandage, assists very materially to bring the deeper surfaces of the wound together, as well as the superficial portion. The pressure made by the bandage must be uniform from the extremity, to prevent passive congestion. The bandage will slacken here and there in a day or two, perhaps in a few hours, and will require to be readjusted. When this becomes necessary, I have been in the habit of applying a second bandage over the first; as to remove the first for the purpose of tightening it would expose the wound too much to displacement.

Adhesive straps are more particularly useful in superficial wounds, as they cannot draw together the surfaces at the bottom of a deep one; and when employed for deep wounds it can only be for the superficial part. They should not therefore in such cases be used alone; as to bring together the lips of a wound, while at the bottom the surfaces remain apart, is not only useless practice, but an actual evil. The space at the bottom of the wound will become filled with liquor sanguinis, the fibrin of which will soon degenerate into pus, and thus an abscess will be formed.

The matter is pent up by the straps and bandage, perhaps, or union of the lips may have actually taken place. Adhesive straps may do more than act upon the lips of a wound if they be passed tightly and entirely around the limb wounded, so as to make pressure at the deeper parts.

Before proceeding to apply straps, the integument around ought to be made perfectly dry, else they will not adhere firmly. They ought to be cut in long strips, which will insure a greater probability of their adhering, and, as well, that rest of muscle so necessary for immediate union. I have very often seen adhesive straps cut so short that they could not possibly secure the above desiderata.

The strips should not be too wide; there ought at the same time to be a space between them, to allow the serum to escape from the wound. It is also important to have the straps fit snugly to the skin in their whole extent: to secure this it is necessary to apply them very deliberately. The straps may be allowed to remain on until the wound is healed, unless they have become soiled with the discharge, in which case they ought at once to be removed. The young practitioner must remember that all of the straps should not be taken off at once, but each one as soon as removed should be substituted by another.

To make the ordinary adhesive straps adhere, it is common to heat them by the spirit-lamp, or by holding the reverse side upon a vessel filled with boiling water. These, however, are not always available. While in the Army of the Potomac, I saw used, to make the straps adhere, the sweet spirits of nitre, and almost invariably the strip adhered firmly after being washed with it. The Emplastum Resinosum is an old acquaintance, and I have often employed it to advantage; but it is often irritating, and may seriously interfere with the union by adhesion. The isinglass plaster I have found far more serviceable and reliable. While in the United States service, I saw many yards of it used, and can confidently recommend it. It is more cleanly, more easily applied, the least degree of moisture causing it to adhere, and it is not irritating. I cannot speak as to its service in amputations, and very large wounds, as in these cases it may fail possibly to secure the necessary repose of the tissue; but in the majority of wounds it is decidedly superior to the old adhesive plaster.

Sutures.—There are several kinds of sutures. There are divisions based on the material employed and on the manner in which they are employed. *First*, as to the method of using sutures. There are the Interrupted suture, the Uninterrupted, the Twisted, the Quill. Speaking generally, the legitimate use of the suture is simply to prevent a sliding motion of the sides of the wound, and not to forcibly draw them together, and thus retain them. Other agents should be employed, which have already been given, to bring and hold the surfaces together. The surfaces of the wound being in contact, or nearly so, then a stitch introduced will assist to fix the parts, so that union can the more readily take place. But the gaping wound should never be forcibly closed by the suture alone, as it, by dragging upon the structures, will produce irritation and twitching of the muscles, while at the same time they will prove inadequate to accomplish what is aimed at.

The number of sutures, and the depth to which they require to be placed, will depend upon the size of the wound. Speaking more particularly of the interrupted suture, it ought not to be introduced until the bleeding has entirely ceased, at least it should not be tied. Care must be taken to have the surfaces strictly in apposition; to secure this the suture will be, at first, introduced in the middle of the wound, and then on either side, as many as may be necessary; but all should be introduced before one is tied. The central one should be first fastened. The knot must not be over the wound, but to one or other side. This is to avoid irritation at the place where the bond of union is undergoing development. After the suture is tied both ends will be closely cut. The surgeon must not forget that it is *only necessary to bring the sides together.* I have very often seen the lips of the wound quite puckered from the suture being too tightly drawn.

It is commonly recommended to allow the suture to remain for thirty or fifty hours, or until there appears a little redness where the suture passes through the integument. The presence of the foreign substance is offensive, and will interfere with the successful issue of healing by adhesion if allowed to remain for too long a time. Therefore, so soon as the wound is firmly closed, the suture ought to be taken away. I think it is more frequently permitted to remain too long than too short a time. When they are extracted, they ought to be substituted by the adhesive straps. The

necessity of an early removal of the suture must not be overlooked, as it may lead to the formation of pus at the bottom of the wound, where it passes through the bond of union.

The Twisted Suture.—The remarks made thus far have been more particularly directed to the interrupted suture, the proper use of which is to retain at rest the surfaces brought together by other means. But in certain kinds of wounds, the surgeon will find it necessary to use the suture to bring together the surfaces. In such cases, to obviate the evil which would result from the ordinary suture dragging on the tissue through which it is passed, a pin, prepared for the purpose, is introduced at some distance from the lip of the wound, and made to traverse the deeper part of the wound to an equal distance from the lip of the opposite side. The second step is to place a piece of waxed silk around one end of the pin, and then wind it around the two ends in the form of a figure eight. An assistant will hold the wound together while this is being done; and when the operation is completed, the wound will be firmly closed. The advantage of this, the twisted suture, is sufficiently plain. The pin fixes the sides of the wound, and the silk, crossed, and bound around the ends, exerts pressure upon the surface of the part, by which the wound is retained close together.

The twisted suture is principally used when there is a loss of integument, or where there is much gaping. It is most frequently resorted to in wounds of the face, when it is desirable to prevent the existence of a scar. It forms a part of the treatment of hare-lip.

The Quilled Suture.—The advantage of the quilled suture is, in most respects, the same as that of the twisted. It is generally used in wounds and operations about the perineum, where the twisted suture could not be employed. It consists of as many interrupted sutures as may be necessary, and two substances about the size of a quill, one placed on either side of the wound. The sutures having been introduced, one end of each is looped around one of the bodies, and the other ends are tied sufficiently tight around the body of the opposite side. By means of these bodies, extending the length of the wound, diffused pressure is made upon the integument on either side, by which the wound is kept closed.

Division of Sutures, based on the material.—There are two kinds of sutures, as to the material composing it. One is of metal —iron or silver; the other is of silk or hemp. The silk suture is of a more ancient use than the metallic; but within the last fifteen years, the latter has, to a great extent, superseded its use. The metallic suture is more cleanly, and less irritating, than the silk; but its removal is attended with some difficulty, and is likely to cause irritation, and disturb the process of healing. I cannot say that I have observed that extra advantage from its use for which it is so strongly recommended.

Fourth indication in the treatment of wounds, is to prevent, or control, or subdue, inflammation. It should be well understood that no extraordinary flow of blood is necessary to secure the healing by adhesion. Healing is a physiological action, for which no excess of blood is requisite; rather the congestion will subvert the process of healing, and lead to inflammatory action.

The local *applications* consist in the use of cold water dressing, in connection with which, the same attention and the same precautions must be observed as are referred to in the treatment of inflammation. It is a fortunate thing that cold applications tend both to the arrest of hemorrhage and the prevention of inflammation.

Such *constitutional measures* will be adopted as are recommended in connection with the subject of inflammation.

The surgeon, in treating incised wounds, seeks to obtain union by primary adhesion; but it will occasionally happen that, either from constitutional defect or the absence of some essential local condition, adhesion does not follow his treatment. Whatever may be the obstacle to union, as soon as the fibrin, which should have served as a bond of union, has degenerated into pus, free egress for it must be made by the removal of the bandages and sutures. And if there be pain, indicating the formation of pus at the bottom of the wound, soothing applications, as a poultice, must at once supersede the former treatment. Healing, thereafter, will have to take place by granulation or secondary adhesion.

CHAPTER XXVII.

Lacerated Wounds: Characteristics—Treatment. Contused Wounds: Treatment. Punctured Wounds: Characteristics—Treatment.

By a *lacerated wound* is understood a solution of continuity, attended with a stretching of the tissue around the wound, from which its vitality is impaired, or perhaps destroyed. The force by which the division of tissue is effected is generally indirect, in the same manner as the force applied by the hands is indirect which tears a piece of linen. The whole of the tissue, between the two points at which the power had been applied, was necessarily placed upon the stretch, and it was a chance circumstance which caused division to take place in one place sooner than in another; hence that injured condition of tissue characteristic of the lacerated wound.

Characteristics.—The wound does not present that even surface which is seen in the incised; rather it is irregular, with ragged margins—uneven edges—perhaps hanging in shreds, or flaps. The *pain*, instead of being of a smarting nature, is more decidedly acute, or perhaps, on the contrary, altogether absent. In the former case, the nerves have been much irritated; in the latter, they have been benumbed or paralyzed.

Hemorrhage is comparatively slight, as the laceration promotes the closure of divided arteries, and the coagulation of blood. The coats more speedily and effectually contract, while the rough and glazed prominences on the surface of the wound offer so many points around which coagulation may commence. Consequently, a comparatively large artery may be divided, and yet the bleeding be speedily arrested by the unaided powers of nature. Cases, indeed, are recorded, where a large limb was torn off and no hemorrhage ensued.

The gaping is by no means so great as in the incised. The injured state of the tissues incapacitates them for contraction, so that, although the wound is of equal size with the incised, the

gaping is much less. The absence of these two symptoms—bleeding and gaping—which are so well-marked in the incised, not unfrequently leads to the belief, on the part of the patient, that the wound is comparatively of little importance. In like manner, the inexperienced surgeon may be misled.

The lacerated wound is more serious, because the injured tissue around the wound has to be restored in vitality before healing can commence.

A lacerated wound may terminate in immediate union, if the tissue have been but slightly injured; on the contrary, there may follow inflammation, or ulceration, or sloughing, or even gangrene. Much will depend upon the extent to which the vitality of the tissue is impaired; also upon the recuperative powers of the system or the part. As a general thing, some portion of the tissue bordering the wound, which has been stretched, will perish, while other portions will gradually be restored to normal vitality. Nature, whose leadings the surgeon must here still follow, will take steps to ascertain how much of the affected structures will recover and how much must perish, and then will proceed to establish the line of separation between the living and the dead. This line will not be regular in its course, but it will be definite. The formation of the line will be followed by sequestration of the *débris*, either in the form of ulceration or sloughing. Simultaneously, the adjacent tissue will be restored to health; and immediately thereafter, healing by granulation will commence. Attending the separation of the destroyed tissue, will be a degree of inflammatory action. This is necessary to the separation. But care must be taken that the inflammation is not unnecessarily great.

The surgeon cannot always be certain as to the termination of a lacerated wound. As before intimated, the wound may be more serious than appearances would seem to indicate. It can never be known to what extent the tissue has suffered; perhaps, while a part of the wound is lacerated, another part is simply incised, in which parts, adhesion may speedily ensue. On the contrary, a part may be bruised, which condition is quite as injurious as laceration. The character of the instrument by which the wound has been inflicted will assist in determining the diagnosis and prognosis. A portion of the instrument may have a sharp edge, while another portion may be blunt; or the cutting portion may have

been followed by the handle, which has forcibly torn the wound wider, or perhaps has bruised the tissue around.

Lacerated wounds are not equally serious in every part of the body. Cases are recorded in which very extensive lacerations of the scalp united very quickly.

Treatment of Lacerated Wounds.—Arrest the hemorrhage, remove foreign bodies, and treat the inflammation; and then,—the pathology well understood, and the physiological action, which will be displayed, properly appreciated,—the duty of the surgeon will be simple and easy. As in the incised, so in the lacerated: the surgeon can but be the handmaid of nature.

The tissue bordering the wound being more or less injured, time and proper circumstances are necessary, that the doomed portion may be cast off and the living portion restored to a state of health. It will be remembered, that, to secure sequestration, the flow of blood does not require to be great; there must not be too much. If the circulation be too free, inflammation is favored, restoration is delayed, and destruction of tissue increased. Inflammatory action will, however, undoubtedly hasten the separation of the destroyed tissue; but it will likewise increase the amount of destruction and the breach to be healed. There must be suppuration; but the flow of blood need not exceed, to any extent, the natural quantity. To secure these essential circumstances, thus indicated, the surgeon has only to maintain the natural temperature of the part, and the ordinary circulation. Although the process of nature in the lacerated wound is quite different from that of the incised, the treatment required is essentially the same. Cold water treatment ought to be adopted, as a general thing; but as the tissue is wanting in that vitality which was present in the incised wound, care must be taken that the cold be not too great. The only guide—and it is infallible—is to apply the water sufficiently cold, and with sufficient diligence, to prevent congestion: the slightest elevation of temperature; and no more than that. In extensive wounds, it will be necessary to administer medicines to control the action of the heart. It has been recommended by some, in those cases where the pain is great from the laceration of the nerves, to apply a cold poultice. In some instances, relief will thereby be afforded; yet a proper use of ice-water will be found to accomplish the same end, and at the same time it will

more surely limit the inflammation. Sometimes, however, in extensive tears, the tissue will have suffered so much, or the system experienced such a shock, that warm applications of water or poultice will be demanded, to raise the heat to the natural standard. As soon, however, as this has been obtained, they must be discontinued; and when the action begins to be excessive, as it will, cold dressing must be employed instead. In these cases, the feelings of the patient will indicate, somewhat, the most suitable application.

In every case, the patient's general comfort ought to be attended to. Repose of body and mind ought to be, if possible, secured to him. When necessary, local support should be supplied by straps, bandages, or splints. In a pure case of lacerated wound, no attempt should be made to bring the sides of the wound together by sutures. The sides ought to be approximated and firmly sustained, but not brought actually together; unless, indeed, a portion of the wound be incised, and there be a fair prospect of adhesion of a part presenting itself. Attention to position is a matter of some importance, so that passive congestion may be averted. When the line of demarcation has formed, and there is a slough to be separated, the occasional use of a poultice may prove beneficial.

Contused Wounds.—In this wound there is bruising or crushing of the tissue. It is *caused* by some body coming against the tissue with a force sufficient to cause a solution of continuity. Also a blunt instrument may produce it, which, although dividing the tissue, yet bruises it in its course. The difference, then, between a pure case of lacerated wound and a contused one, is this: in the former, the tissue has been stretched until its vitality has been impaired; in the latter, it has been subjected to bruising until its integrity has been affected.

The *characteristics* are nearly the same as those of the lacerated wound. The surfaces are irregular, the margins uneven. The pain is not great, perhaps absent, the nerves being bruised to numbness. Hemorrhage is not great; but in the bruised and jelly-like tissue around, there is more or less effusion of blood. The vessels do not contract so much as in the lacerated; rather they are dilated, at least are unable to contract. The result is, an escape of blood into the softened tissue. But, although the bloodvessels do not contract, the state of the tissue favors quick

coagulation, so that hemorrhage is not great as a general thing. Sometimes the blood will collect in the tissue, the presence of which will cause pain, and perhaps make an incision necessary.

The bruised state of the tissue, and the dilated condition of the vessels, are often the cause of secondary hemorrhage. This unfortunate complication is more apt to follow in the process of ulceration or sloughing, than in the lacerated form of wound.

Terminations and Treatment.—The *terminations* of the contused wound are in all respects the same as we have found in connection with the lacerated; and the *treatment*, in the main, is the same. When blood has collected in the vicinity of the wound, and is productive of pain, and which may lead to sloughing, a way of escape must be provided. The danger of sloughing and secondary hemorrhage must be remembered by the surgeon, and great care observed to limit the amount of destruction by ulceration. The circulation of blood in the part, in a normal manner, is of the greatest importance. The crushed tissue will not at first endure much cold; but as it returns to life, there will be great danger of excessive reaction, rendering necessary the application of cold.

In the treatment of both lacerated and bruised wounds, when they are extensive, and it becomes necessary to resort to antiphlogistic means to subdue inflammation, the surgeon should remember that, in addition to the shock from which the patient has suffered, there will be a discharge, more or less exhausting, which together may overcome the powers of life. The immediate danger must be met, but the mildest means possible should be adopted. Instead, therefore, of depletion in any form, the strength ought to be husbanded, and perhaps the strongest stimulants resorted to. This may be required even from the first.

Punctured Wounds.—This form of wound is important both on account of its frequency and its peculiar character. By it is commonly understood a penetrating wound made by an instrument more or less pointed, but not actually sharp, such as a bayonet, the tine of a fork, a dagger, or the point of a sword.

Characteristic Symptoms.—The external appearance never indicates the depth to which the instrument has penetrated, nor the direction of the wound. Consequently, the surgeon cannot know which of the tissues have suffered, nor the degree of danger. The small orifice will often lead the patient to think lightly of the

wound, while it may be of the most serious nature. There is no gaping, but little pain, and unless an important vessel is wounded, there will be very little hemorrhage. Consequently the *diagnosis* is difficult and the *prognosis* uncertain. The wound is generally both bruised and lacerated, and in places it may be incised. This will depend upon the size and shape of the weapon, and the force with which it entered the body.

Diagnosis.—The region of the body in which the wound exists may assist in the diagnosis. When it is in the abdomen, particularly, there will always be reason to fear that important structures are wounded. Although the appearance of the wound will not indicate the degree of injury, there are other symptoms by which it can be, to some extent at least, estimated. There is generally a shock to the constitution when an important viscus is involved, which shock generally corresponds to the degree of danger. When a bloodvessel is wounded, hemorrhage from the wound will make it known, unless the blood can find a cavity into which to flow. If a nerve be divided, a loss of sensation will indicate the fact. The size and shape of the weapon, the direction it passed, and the force with which it penetrated the body, will, *when known*, afford valuable assistance in the diagnosis. The direction may be learned by careful probing, yet this must be done with the greatest care. In view of the danger of causing further injury, by the use of the probe, it is better practice to endeavor to learn the depth and direction by other means than the probe. When it is deemed necessary to use it, let it be handled with the gentlest touch, lest a vessel partially severed may be opened, or other mischief result.

Treatment of Punctured Wounds.—The ordinary indications will be pursued. But more than ordinary difficulty may be experienced in stopping the hemorrhage. Of course, when it is within a large cavity, as the abdomen, it will be beyond the reach of the surgeon. And when it is not, the small size of the wound and the uncertainty of its source may cause much embarrassment. The blood wells forth in a continuous stream, but the wounded vessel is hidden, its depth unknown. In such cases it has been recommended to widen the wound externally by incision, that the artery may be secured. This operation, however, is both painful and difficult. The better course is to apply direct pressure, by plugging the wound. The plugging must *commence at the bottom*

of the wound. If the vessel is at or near the bottom, this will be necessary, and if it is not, the space at the bottom beyond the point to which the plug reaches will be occupied by a clot of blood, which clot will expand and tend to force out the plug. The wound must be completely filled from the bottom, and a piece of adhesive strap applied over the wound to retain the plugging.

Subsequently, there will be no haste to remove the plug. The great danger attending the wound in this case is hemorrhage; and to remove the clot at an early day, or perhaps to extract it at all, will be to expose the patient to the danger of secondary hemorrhage. Possibly, however, so much inflammation may arise that *gentle* extraction of the plug may be demanded. When the plugging fails to stop the bleeding, as it sometimes will, it then becomes necessary to tie the artery. As the surgeon cannot be sure as to the precise spot whence the blood flows, it is recommended to cut down on the cardiac side of the wound, where the artery can be conveniently reached.

Sometimes a foreign body will be so fixed in the wound, it may be a portion of the weapon, that it will be necessary to widen the wound in order to extract the substance.

Terminations.—The terminations of punctured wounds are much the same as those of the forementioned, with this addition, that a sinus may result. Healing by granulation may generally be expected in due course. To obtain this, the treatment will be the same as for the contused wound. It may be desirable to apply a poultice, in order to keep the wound open externally, as the healing must commence at the bottom. There must be, at all times, a free way of escape for the fluid, otherwise pus will collect in the depth of the wound.

When constitutional symptoms give indications of serious internal complication, the various symptoms must be promptly met, the case being diligently watched.

CHAPTER XXVIII.

Gunshot Wounds: History—Division—Missiles—Velocity—The Kind of Injury—Position of Body—Location of Ball.

In considering this class of wounds it is well to include all solutions of continuity which are *produced by explosion*, by which a substance is projected, and which, coming in contact with the body, breaks the tissue.

The history of gunshot wounds is not uninteresting. Much importance has always been attached to such on account of their associations; but in the present work, where practical points alone are dwelt upon, space cannot be given to the subject.

Divisions.—A division of gunshot wounds may be based upon the causes of the wound, thus: 1st. Those caused by explosion of powder alone. 2d. Those by the shot-gun. 3d. Those inflicted by a ball, which may be round, or conical. (In modern military practice the latter is more frequently met with.) 4th. From a grape-shot. 5th. By pieces of shell. 6th. Wounds produced by some material, which itself has been struck by a ball. 7th. Injuries due to spent cannon-balls, causing destruction of bone, or rupture of internal organs.

Again, the wounds may be divided into such as are inflicted *directly*, and those which are *indirectly* made. That is to say, the missile which inflicts the wound may be directly or indirectly driven by the explosive powder against the body. There are several circumstances connected with this division, which may modify the character and extent of the wound, as well as the effects upon the constitution.

Another division is given in Holmes's System of Surgery, based upon the shape of the body which has made the wound. The round ball makes a wound mostly spherical. The modern conical ball produces a wound more of a cylindro-conoidal shape. Then there are wounds made by bodies of no particular form; these are designated irregular. Such may be due to a bursting shell, or bits

of wood, or stone, or iron, which have been struck off from structures of that material. Again, extraneous matters may enter the body at the time the wound is produced, as bits of clothing, or pieces of money, or buttons, or even a portion of bone from another individual. These unusual forms of wound, the irregular, are not easily diagnosed. And when discovered, the prognosis is uncertain.

Characteristics.—Again, the weight of the object which divides the tissue will give character to the wound. A missile, when possessing little weight, and propelled by a certain force, will cause less destruction of tissue than a more weighty one. The weight, however, has a less modifying effect than the size or shape. But cannon-balls are eminently destructive, whether the velocity be great or otherwise.

"Double bullets, linked together by a spiral coil of wire, something after the manner of chain cannon-shot, were introduced by the Russians during the war in the Crimea. Specimens of these bullets were found about the works around Sebastopol, but no injuries received from them have been recorded, although after the discovery, peculiarities in the characters of some wounds, which had not previously been satisfactorily accounted for, were supposed to have probably resulted from them. It seems likely, however, that when discharged, the divergent forces impressed on the two bullets were sufficiently great to break apart the connecting wire, which was of very slender diameter, before they came in contact with the troops against whom they were directed. Dr. Scrive, in his History of the Eastern Campaign, mentions also that incendiary balls were employed by the Russians. They consisted of a small cylinder of copper, containing a detonating composition, and made up into the form of an ordinary cartridge, so as to be discharged from a musket. On hitting its object the projectile bursts with violence. These balls were not known till after the conclusion of the siege, and it was only then, M. Scrive remarks, that a key was obtained to some wounds of a frightful character, which could not be accounted for by the action of ordinary bullets, or fragments of shell."

The Influence of Velocity.—As has been intimated, *velocity* has much to do in giving character to the wound, whatever may be the missile. The ball from the Enfield rifle, which will speed on its

death-errand for a distance of 1000 yards, will, in the first part of its course, prove far more destructive to tissue and to life than did the old rifle-ball, which could take no effect beyond 250 yards. And the musket-ball, being round, will, when going with its greatest speed, cut the tissue, without a serious amount of bruising or tearing; but the conical ball, perhaps in consequence of its shape, but more likely from the boring manner in which it passes through the tissue, produces a great deal of injury to it. That is to say, extreme velocity in the round ball lessens the degree of danger, while in the conical ball it increases it, whether it strikes the soft or hard tissue. The following, as to the contrast between the effects of the old fire-arms and those in use at the present time, will be found interesting and instructive:

"The velocity of motion of different projectiles is an important ingredient in the consideration of the several wounds produced by them. The rates of motion imparted to missiles by the fire-arms of early times were probably—from the imperfect construction of the weapons, defective quality of gunpowder, and other circumstances—as inferior to those of the musket lately in use as the velocity of musket-balls was to that of the conical bullets of the rifles in present use. In a table showing the velocities of certain moving bodies, published in 1851, the common musket-bullet is set down as moving at the rate of 850 miles per hour; the rifle-ball of that time at 1000; the 24-pound cannon-ball at 1600 miles per hour. But the musket-ball then could not be depended on to hit an object beyond 80 yards, the rifle 200 to 250 yards; while the present Enfield rifle is sighted to 900 yards, and the short Enfield to 1100 yards. The effects of different rates of velocity on wounds are seen in the variations which occur in proportion to the distance which the missile has travelled before inflicting the injury. A cannon-ball which, with but slight velocity of motion added to its weight, would knock a man over, at ordinary speed will carry away a limb without disturbing the general equilibrium of the body. A musket-ball that would be arrested half way through a limb, is now replaced by a ball which, at like distance from the point of discharge, will pass through several bodies in succession.

"The increased velocity, or, in other words, greater force, of modern projectiles, exhibits its effects in two directions: locally, by the greater destruction of tissues in the track of the projectile;

and constitutionally, by greater disturbance to the nerve-force of the whole system. The component parts of that portion of the organized fabric through which a bullet, travelling at the rate of several miles per minute, cleaves its way, are inevitably deprived of their vitality. Instances are quoted by authors, of gunshot wounds having healed by simple adhesion; but such examples are not met with from rifle-bullets retaining their original form. Moreover, when considering the course taken by balls in the body, it will have to be shown that the velocity imparted to projectiles from modern weapons has led to another change in gunshot wounds. The great power of resistance so often before exhibited by the yielding elastic tissue of the skin, by tendinous and other structures, is no longer of avail against projectiles from modern fire-arms, at their usual rates of speed.

"The splitting and destructive effects of conical balls on the shafts of the long bones of the extremities, have already been mentioned when referring to the peculiarities of their shape. But, together with form, the amount of momentum is a necessary ingredient in estimating this result. The old round balls,—partly from their form, but also from the imperfect mechanism of the firelocks from which they were discharged, and consequent minor degree of velocity imparted to them,—on striking bones, would simply be turned away from the direct line; or, failing this, would knock out a portion of the shaft, without further fracture; or, having perforated on one side, remain in the cancellated structure; or be simply flattened without penetrating. It seems not unlikely, also, that the modern conical bullets are denser, from the circumstance of their manufacture by mechanical pressure, than bullets, such as are still used in some places, cast in moulds. The influence of density, with respect to power of penetration, is very great. In the two most perfect of modern English rifles—the Enfield and Whitworth—the projectiles and charges being of the same weight, when lead is used, the penetration at 800 yards is one-third greater with the Whitworth than the Enfield; but if a less yielding projectile is used (as when the lead is mixed with tin), its penetration is as 17 to 4 at 800 yards. Whether this cause operates or not, the fact is certain that conical balls in action exhibit almost invariably an overpowering force over all the structures, bone included, with which they come into contact in the human body,

and are rarely met with flattened, or so much altered in form, as bullets not unfrequently were formerly under like circumstances." (Prof. Longmore, Syst. Surgery.)

Another kind of injury is that arising from a spent cannon-ball. It is not due, as formerly supposed, to the concussion of the air, but to the weight of the ball, which rolls along with only sufficient momentum to overcome the force of gravity. A body lying upon the ground will not arrest its progress, but the ball will roll over it. If it be a leg or arm, the bones will be crushed by its weight; or if it be another part of the body, life may be destroyed. The most extraordinary feature is, that the skin and other soft tissues are often entirely uninjured. Tissues that will yield under the weight will, as a general thing, escape. For instance, a ball rolling over the abdomen may produce rupture of the liver or other viscera, while the walls remain unaffected.

Upon the velocity will also depend whether the missile lodges in the body, or completely traverses it and escapes. When the speed is limited in degree, the tissues of the body, especially the bone, will arrest the missile, causing it to lodge in the body. The modern Minié and Enfield balls travel with great swiftness, and consequently lodgment is not so common, relatively, as was formerly the case. In a letter to the London Lancet, written after a visit to the military hospitals in and about Washington, in December, 1862, I wrote respecting this subject, as follows, speaking of a museum which was in preparation at Washington, consisting of dried specimens of wounded bone: "The bones, being thoroughly cleaned, are arranged with much skill on wires, so as to show the manner in which the ball had entered, the effects immediately produced, and subsequently the efforts made by nature to repair the injury. By this means, it is clearly demonstrated that the Minié ball is but rarely turned aside by the bone; and that, although the ball is generally much battered, it will pass through even the largest bone, or, if the momentum be not very great, it will bury itself in the osseous tissue. In every instance, the bone was seen more or less comminuted, even where the ball had seemingly passed through the bone with considerable force. From looking at these specimens, it would appear as if the cone-shaped ball passed into the bone in a wabbling manner, and that thereby great destruction, characteristic of that ball-wound, is accomplished."

Again: "The Minié ball, when it strikes a bone, produces extensive comminution; while all along the track where it has passed, in the soft parts, there is a good deal of destruction of tissue."

The round ball is sometimes turned aside by a bone, while at the same time its momentum may be so much lessened, and the ball so battered, that it will lodge in the soft parts.

The ball, both Minié and round, is often found, when lodged in the body, in a part quite remote from the place of entrance, and located in a place most unexpected,—in a place to reach which it would seem to have taken a very circuitous route. This, when it is the round ball, may be attributable to the power which bone has to turn it aside; but it is more generally due to the peculiar position of the body at the time the ball enters it.

When it is remembered that the body is capable of assuming a great variety of positions—that the limbs, one or more may be stretched, or flexed in different directions, and that during the conflict the soldier will necessarily be at times in every conceivable attitude, while the enemy may fire upon him from different directions, it can be readily understood that not only may the body be wounded in any part, but the ball may pass in every direction through the body or limb. At the first battle of Fredericksburg there were a certain number of men placed in a very exposed position. This was done during the night, and in the morning they had to lie flat upon the ground to be safe from the Confederate sharp-shooters. This position was held during the day; and now and then, when the head of one of them was raised to the slightest extent from the ground, it became a target for the rifleman. The result was that a large number were wounded in the head, face, neck, and summit of the chest. In some cases the ball had traversed the neck obliquely. Sometimes it had passed parallel with the body, and into the thorax and abdomen.

I saw not a few cases in which the ball had travelled along through a limb. Sometimes from the knee, striking the limb when flexed, up through the thigh into the pelvis, or down the leg to the ankle. Also up or down the arm. Sometimes the same ball had inflicted several wounds. One case which I saw after the battle of Chancellorsville, will serve to illustrate this fact, as well as the extraordinary direction the ball may take. A private of one of the New Jersey regiments had been wounded in the right arm

while in the act of putting a cartridge into his musket. The ball had completely cut off his forefinger, then passed directly through the body of the hand, and again entering the back of the arm, about two inches above the wrist, had ploughed a furrow for a few inches, and then entering into the deeper part of the arm, had finally made its exit and escape a little above the external condyle of the humerus. Now, it can be at once understood from the foregoing, that when the ball, instead of making its escape from the body, remains within it, it will be exceedingly difficult to ascertain its locality. Not only may the ball be lodged in a part very remote from its place of entrance, but chance may have taken it in one direction, or perhaps the opposite. It will be impossible to tell its course unless its track can be traced externally, or the patient can call to mind the position he was in at the time he was wounded, and the direction the ball came; but then, even, it may be impossible to say whither it has passed.

The difficulty of ascertaining the locality of a ball is increased by the fact that its own weight will often lead to displacement from the first place of lodgment. And, also, the contraction of muscles may cause it to move to some extent. Not only do balls lodge in the body, but also any one of the missiles which produce gunshot wounds; such as pieces of shell, or stones, or bit of wood, or a button, or a piece of clothing, or even a comparatively large grape-shot. Several interesting cases are recorded in the System of Surgery, by Holmes, where a grape-shot had unexpectedly been found lodged in the body. And I have now before me one, not very large, which was excised near the spinal column between the scapulæ. It had entered behind the left shoulder and passed beneath the scapula.

CHAPTER XXIX.

Symptoms of Gunshot Wounds—Treatment: Local—General—Primary, or Secondary Operations.

Symptoms of Gunshot Wounds.—We have to consider those that present themselves in the part, and those which affect the whole constitution.

The Local Symptoms are in many respects the same as those which have been given in connection with lacerated and contused wounds. The characteristics are, generally, much crushing of tissue, and very often considerable tearing of the structures. The conical ball especially, boring its way through the tissue, is eminently destructive to its vitality, and along the whole of its course will be found a lining of tissue so injured that it will inevitably perish. The effects of the round ball upon the tissue will depend, to some extent, upon the velocity of the ball as it divides them.

Pain may be almost or altogether absent. It is characteristic of gunshot wounds that the pain does not altogether depend upon the degree of injury or irritation to which nerves have been exposed; but, to a great extent, upon the temperament of the individual, and the state of mind in which he was at the time the wound was inflicted. So true is this, that the soldier may be seriously wounded, and yet be unconscious of the fact. Wrought up to the highest pitch of excitement by the engagement, and the consciousness of facing death, a dangerous wound may have been received, and still the recipient rush on in the bloody strife. While, on the other hand, where fear is predominant, the first rally from the enemy may cause the sensitive one to fall down, impressed with the belief that a dozen balls have pierced him. And, subsequently the intensity of the pain will depend upon the state of æsthesis in the patient. The circumstances of camp-life may contribute to extreme sensitiveness. Whatever be the cause, I observed a good many wounded ones, many of them with slight

wounds, yet who suffered excruciating pain, while others experienced but little.

Hemorrhage is not, as a general thing, very great. The fact that the wound is lacerated and bruised would promise the absence of bleeding. We have, however, the testimony of the experienced Guthrie, that hemorrhage is often considerable.

But, while the primary hemorrhage, it may be said, is not common, secondary hemorrhage is very likely to occur. The injured state of the tissues necessitates the process of ulceration at least. (*Vide* Lacerated Wounds.) Attending this, will be, to some extent, the inflammatory process. This will often lead to the opening of vessels. The ball in its passage impinges on arterial coats, affecting their integrity; and subsequently, the process of ulceration sequestrates the injured portion and thereby opens the arterial tube, and bleeding is the consequence.

Gaping is not very great in gunshot wounds. Oftentimes, on the contrary, the lips are inverted, especially where the ball had entered, and where it emerged there is, at least, an absence of gaping, so that very frequently the orifice is seemingly less than the size of the ball.

But although the wound at the place of entrance is often characterized by inversion of the lips, yet such is not always the case. After considerable attention to the matter, and careful observation, I have to say that there is no regular order concerning the relative size of the orifice of entrance and of exit. I have frequently seen the wound where the ball emerged, even smaller than that made by its entrance. Sometimes the ball will travel some distance immediately beneath the skin, and its course will be marked by a somewhat livid mark. By passing the finger along the route a sensation of crepitus will often be experienced.

Constitutional Symptoms.—The first is the well-marked shock. Sometimes it is slight, but more frequently it is very great. No doubt this is due in part to the circumstances of battle, and to the actual shock imparted to the nervous system. I have repeatedly asked those who had been struck with a ball, as to the nature of the sensation at the moment. As before said, some are not even aware of the fact, until weakness or helplessness, or the loss of blood acquaints them with it. Those who could call to mind the sensation when wounded, described it as something resembling a

very heavy blow either upon the part wounded, or upon the body generally. The prostration consequent thereupon, is sometimes very great and alarming. Of course when an important structure is involved, the shock will be correspondingly great.

Other constitutional symptoms will supervene. These may be due to loss of blood, or exhausting discharge, or local irritation, or want of rest, or imperfect diet or nursing. Then there are a variety of complications which often present themselves, as, for instance, pyemia.

The *prognosis* of gunshot wounds should always be exceedingly cautious, more especially when the shock is severe, or there is reason to fear that deep-seated parts are involved; and also from the fact, just above stated, that serious constitutional complications may supervene.

Treatment of Gunshot Wounds.—The *local treatment* will be somewhat modified, according as the wound partakes of the character of the incised, the lacerated, the bruised, or the punctured. It is scarcely necessary to say that it is desirable to have the foreign body removed. With respect to balls which may have lodged, when their locality is discovered they ought, if possible, to be removed. Formerly, it was recommended to take no great trouble to effect their extraction; but according to recent practice they are, if possible, at once removed. If allowed to remain, the ball may become encysted, especially when in muscular tissue. (Syst. Surgery.) But more generally the foreign body is a continued source of irritation, pain, and danger. *This course is recommended when the position of the ball is known;* but when it is not, it becomes a question how far efforts should be made to learn its whereabouts by probing. A wound may be probed by the metallic probe, or by the finger. According to the high authority of Longmore (System of Surgery), it is preferable to use the finger. But if the probe is handled with great gentleness, as the probe ought always to be used, it is less likely to cause irritation and extend the depth of the wound. I cannot omit expressing a firm conviction, founded on close observation, that wounds in which the ball is lodged are too often subjected to rough examination, both with the probe and the finger. It is a question, in case of a wound near an important structure, as a knee joint, whether the advantage to be obtained by probing is commensurate with the

risk of forcing the probe into unbroken tissue. Not a few cases came under my notice while in the United States service, in which pyemia and death ensued after the use of the finger to discover the ball, although the patient did not seem to be predisposed to such diseases.

Before commencing to explore the track of a ball, the patient should be placed, so far as it can be known, in the position he was when wounded; otherwise, the channel will be obstructed by the relative change in the position of structures. The ball will sometimes be buried in the bone, in which case all efforts to remove it will prove useless; and occasionally it will remain without causing any inconvenience or irritation. Should it produce irritation that will lead to a separation of it from the bone, then it can easily be extracted. The instrument with which removal is effected is very commonly the bullet forceps. Objection is, by some, made to these, because of the necessity of separating the blades to grasp the ball. Professor Longmore, of the Military School, Netley, recommends the extractor, consisting of a scoop for holding, and central pin for fixing, the bullet.

There is a possibility of being too solicitous to extract the ball. Of two evils, the surgeon ought to choose the least; and while the ball, as any other foreign body, ought to be removed, it should not be forgotten that the efforts to remove it may be productive of more evil than the ball would be if left to nature. Protracted and violent efforts cannot be recommended in any case. Before searching for a ball in the wound, careful examination ought to be made, with the hope of detecting it in some subcutaneous position, as in such cases it will be preferable to make a direct incision upon it. Very often, although not always, the patient will become aware of its position by pain or uneasiness in the part; perhaps not at once, but after a few days. One case, which just comes up in my mind, I will give as an illustration. Sergeant C—— had been wounded in the leg, I think while advancing at the double-quick. The ball had entered to the front of, and a little below, the knee. It was a fortnight afterwards when he came under my care. In the mean time, the wound had been repeatedly probed in the efforts to find the ball, but without success. Believing, from the character of the wound, that the ball had taken a downward course, I proceeded to carefully examine the leg on every side. Coming to the ankle,

and while pressing the finger inward beneath the tendo-Achillis near its attachment, he complained of soreness, and at the same time I could distinctly feel a hard substance. The patient, assured that this must be the ball, submitted at once to the use of the knife, and a large Minié ball was extracted through the wound. It had not caused, so far, any inflammation. The ball was slightly battered from striking the bone. Of course, the patient was delighted, as well as surprised. Now, here is a case illustrative of the usefulness of trying, by external examination, to find a ball, when the probe fails to reach it through the wound. The ball was not only more than a foot from the place of entrance, but it was also at the opposite side of the limb. Moreover, the ball had been lodged for fully two weeks without creating inflammation, and the wound which was made to remove the ball healed in a few days.

The surgeon, before using the knife, must be certain of his diagnosis. I have known an incision to be made upon the external condyle of the humerus, with the belief that it was a ball. Other foreign bodies, such as bits of cloth, or a button, will be removed when discovered; but the rules of procedure are in no way different from those detailed in connection with punctured and contused wounds. Also with respect to subsequent treatment, the principles are the same as those given before. It will be borne in mind that the surrounding tissue has been much injured, and that time will be required to establish the line of division between the tissue which can recover and that which will perish.

Constitutional Treatment of Gunshot Wounds.—In the first place, it is not unimportant to state that great care is essential in removing a wounded man from the field. The surgeon is called a non-combatant officer, sometimes in offensive tone; but he willingly goes on the battle-ground while the conflict rages, to relieve the distressed, to succor from death, while he has not the excitement to sustain him which the officer in command even of a few men has. Under such circumstances, it will often be impossible to do more to a wounded man than to arrest the hemorrhage, perhaps by temporary means. There is commonly a place of comparative safety for performing those primary operations which are required. The wounded will be conveyed to this place upon a stretcher. A recent writer, German, recommends a kind of wheelbarrow as the most suitable vehicle to use, and which can be

managed by one person. The surgeon upon the field will see the wounded comfortably placed upon the stretcher, taking a part to save any limb that may be injured from unnecessary motion.

Inasmuch as there is generally prostration from the shock, and the work of restoration will be attended by nervous irritation and exhausting discharge, the powers of life must be from the first husbanded, or perhaps supported. If antiphlogistic measures be required, they ought to be adopted with caution.

The question will often have to be decided, in a practical way, whether primary or secondary amputation should be performed. In a communication to the London Lancet in 1863, after having inspected some thousand cases of wounded, and heard the opinion of several surgeons, competent to judge, in the American war, I expressed the following opinion:

"Although a strong advocate of conservative surgery in the broadest sense of the term, I became convinced, that, upon the field, amputation was less frequently resorted to than it should be; that while, in a few cases, the operation was unnecessarily performed, in many cases it was omitted when it afforded the only chance of recovery. The Minié ball, when it strikes a bone, produces extensive comminution; while all along the track where it has passed, in the soft parts, there is a good deal of destruction of tissue. Now, if absolute rest could be secured to the patient, in many cases nature would be adequate to effect repair; but the circumstances of war, the frequent and in many cases careless removals to which the wounded are subjected, preclude the possibility of recovery under the care of the most judicious surgeon. In very many cases, were primary amputations practised, the system, rid of a great source of irritation, would safely endure the subsequent disturbance. Perhaps, in injuries involving the leg, and more especially the (knee and) thigh, such proves more generally to be the case." I saw not a few, upon whom secondary operations were performed, and who subsequently died; but had the operation been resorted to at first, the life would have been preserved.

CHAPTER XXX.

Poisoned Wounds—Three Varieties.—(1) Dissecting Wounds—Symptoms—Treatment.—(2) Stings, &c.

Poisoned Wounds.—Speaking generally, by a poisoned wound is meant the introduction of a poison into the system through the wound at the time it is inflicted. But it is necessary to include under this term all wounds, or sores, or abraded parts, which may have been poisoned by the contact of the virus. And, even more than this, it is desirable to include also those cases which, although the wound or sore is not directly poisoned, become so by the poison being otherwise imbibed by the system, as when the cuticle is very thin, or when a part is for a long time exposed to the poison, or when the poison is very virulent.

Sources of Poison.—Poison may be derived from a mineral, a vegetable, or an animal source. It is the last, where the poison is of animal origin, that we have here to consider. This may arise from different sources. 1st. From dead animal matter, which is undergoing decomposition, or about to do so, as from the dissection of a body, or from making a *post mortem* examination. 2d. From a healthy living animal whose bite, or sting, is naturally poisonous to the human system, such as bites of serpents, sting of bees, &c. 3d. From a diseased living animal, which may be communicated by a bite, or by inoculation; of these we have hydrophobia, glanders, &c.

Dissection Wounds.—With respect to the first of these three classes, the most important is the *Dissecting Wound.* This poison may be from the dead animal matter of the body which is being dissected, or examined; or it may be a poison which had been developed in the system prior to death, and which probably had caused it. In the latter case the virus is more potent, and the result more likely to prove fatal if the poison be received soon after the death, than it will after some time has elapsed. This is especially so in puerperal peritonitis.

Division.—There are two general forms of dissecting wounds—acute and chronic. The acute is rapid in its course, and mostly fatal in its termination. The chronic is generally mild in its nature, and, although tedious, not often fatal.

Mode of Introduction.—The modes of introduction into the system are two—one general, the other local. The general cause may predispose for the local cause; that is to say, the system may become gradually affected from long-continued dissecting, or extended exposure to the poisonous air of a dissecting-room, which not only affects through the lungs, but also by the skin. And an individual with the system thus contaminated, if wounded by *any* instrument, will very likely have all the symptoms of a dissecting wound. It is not necessary that the poison should be introduced by a wound made in the dissecting-room. *Any wound from any cause, or a local inflammation from any cause*, is quite sufficient to give rise to the disease. The system being poisoned, and a part becoming injured, instead of the healing process being commenced and carried on as in health, inflammation of a specific character ensues.

A wound may be received while in the dissecting-room, and the poison actually coming in contact with the divided tissue, be at the time received into the system; yet had there not previously been contamination, the local reception would not have led to the train of symptoms which follow. Indeed, many of the local symptoms are often due to the previously poisoned state of the blood. Those students who most frequently contract the disease, are they who have for a long time been dissecting; while the one who has but recently entered upon that part of medical study, may cut himself, if in health, with impunity. In those cases where the disease was seemingly due to the imbibition of the poison through a recent wound, it will very often be found that some other predisposing cause had been in operation, and that the disease arose, not so much from the dissecting wound, as in consequence of constitutional depravity. A system vitiated by the existence of any poison, or weakened from any cause, is thereby rendered liable to attacks of this disease, if a wound happens to be inflicted. Under such circumstances the work of repair cannot proceed; initiatory steps may be taken, but they come far short. It is indeed, a disease of the healing process.

The dissecting wound, or a wound in connection with the poisoned system, may be incised, or lacerated, or bruised, or punctured, very frequently the last. Next to the degree of poison in the system, the intensity of the disease will depend upon the nature of the wound, whether incised, or otherwise. The disturbance consequent upon the infliction and the healing of an incised wound, may be so slight that the disease is but imperfectly developed. But the more tedious process of repair incident to lacerated and contused wounds,—the inflammation, and the ulceration, and the suppuration cause too much irritation for healthy repair, and turn the process into one of disease. It will be remembered, that even in ordinary inflammation the blood soon becomes affected, as indicated by inflammatory fever. When a poison exists, effects will be all the more speedy and intense, in consequence of the inflammatory process.

Of course, the more potent the poison, the more decided the effects thereof. And the poison derived from dead bodies, as before intimated, is not always the same. That resulting from the inflammation of serous tissues is often particularly infectious; when it is the peritoneum the virulence is increased, and when the peritonitis is due to a specific disease, as the puerperal peritonitis, it is eminently so. Hence the danger of examining the bodies of those who have died of this disease. Several cases are on record where speedy death followed very slight wounds while examining such subjects.

Local Symptoms.—These will naturally depend upon the nature of the poison, and the character of the wound. In the milder cases nothing unusual may be noticed for a few days, when the sore will assume the form of an unhealthy ulcer. Inflammation, instead of entirely subsiding, lingers in the part, perhaps with a good deal of redness of an erysipelatous cast. One or more vesicles may form around the wound, which sometimes become pustular. As the disease increases, the redness extends up the limb in the course of the absorbents, and attending it will be more or less tenderness and swelling. The glands become irritated and enlarged in the discharge of their function to arrest the poison in its passage along the absorbent vessels. These local symptoms may pass away, the poison having been successfully eliminated from the system. This favorable termination will result, when the poison

has not been very virulent, nor great in quantity, and the constitution of the individual is in other respects healthy, so that the powers of nature were capable of overcoming the action of the poison. But, even in these milder cases, time and judicious treatment are essential. The disease is chronic, but mild.

When the disease is acute the symptoms are better marked, and quick in their progress. In the part wounded there is a low form, but a destructive inflammatory action. It soon extends up the absorbent vessels, and the glands become much inflamed, and suppuration of a low order will quickly follow. The whole limb will become œdematous. Pain, which in the milder form was but little, is of a dull, but distressing nature. Redness with a livid cast is not confined to the track of the vessels. It is the arm which is generally affected; and the local disease continuing to extend, passes the shoulder along the anterior and posterior parts of the thorax. Although the limb is much swollen and in places intensely red, yet if an incision be made the quantity of fluid to escape is very limited. The blood circulates through the tissues sluggishly at the first, and at last becomes stagnant. Perhaps, in places the tissue is undergoing changes which indicate its death. When such local symptoms as these present themselves the case may be looked upon as one which is very likely to prove fatal, notwithstanding all efforts of nature, aided by treatment.

Constitutional Symptoms.—In the milder form of the disease the constitution is but little affected; but it is far otherwise when the acute disease attacks a part. Then, of course, there are cases intermediate in degree, in which constitutional symptoms will be more or less severe. One of the first constitutional effects is a dulness of the spirits, a degree of lassitude, with loss of appetite. Then diarrhœa will come on. All of the excretions are exceedingly offensive. Not only the breath, but the exhalations from the skin, are strikingly putrid. It has been observed by many that the offensive smell bears a resemblance to the dead body from which the poison was derived. In the comparatively milder cases these symptoms may gradually wear away. In the severe, extreme prostration will supervene, with delirium, or coma. The bowels, sometimes, instead of being relaxed will be constipated. There is commonly in the worst cases, fever of a typhoid type, with occasional profuse perspiration. The tongue is at first pale and flabby,

or perhaps coated, with a tendency to become dry and cracked. The patient soon sinks, overcome with the virulence of the poison, which completely crushes out the vitality of the system.

Treatment of Dissecting Wounds.—To an ordinary wound, made by a scalpel while dissecting or making a *post-mortem* examination, but little attention is required. It is only necessary to thoroughly wash the part, and then promote bleeding by placing the wound to the lips and for some minutes sucking it. Although there may be no bleeding, yet the suction will extract the fluids around the wound and at the same time the poison, which may be located in the part, and which the absorbents have not had time to carry away. When there is reason to suppose that the system is already imbued with the poison, or when the poison is of a virulent kind, further steps will be necessary. And it will be remembered that a lacerated or a bruised wound is more likely to prove serious than an incised one; not only because the work of repair will be more complicated, but because in the incised wound the hemorrhage is greater, and by it the virus is more likely to be washed out of the wound. The great object to be aimed at is to turn the current by which the poison would be carried into the system, and cause it to flow from the wound. Bleeding is to be favored, by bathing the part in warm water. If possible, the repeated application of a cupping glass may be tried. It has been recommended to make incisions, with a knife, in the wound, with the view of causing bleeding; the utility of this is, however, doubtful. While certain small vessels are opened, and blood flows therefrom, the virus may by others be gradually travelling to the venous current. It is probably better practice to apply a ligature tightly around the limb, a short distance above the wound, and thereby arrest the current of venous blood, which may be the vehicle of the poison, and there cause some degree of hemorrhage.

The cautery has been highly recommended by some, but there is some reasonable doubt respecting the propriety of employing it. When the constitution is not already contaminated, the application of nitrate of silver may, by destroying the tissue in which the virus is deposited, prevent its entrance into the system; but it is a question if less painful measures, above given, would not answer equally well. But when the constitution is already impregnated

with the poison, the caustic can be of no possible use; while it is sure to increase the local inflammatory action, which, we have seen, is calculated to intensify the general disease. Indeed, nothing should be applied that can increase the morbid action. Of cauteries, the nitrate of silver is the least objectionable, as it dries up the tissue, in a measure, and the subsequent separation of the eschar is not attended by the same amount of inflammation as that following the use of more destructive cauteries.

Respecting constitutional treatment, but little need be said. It is, in the main, the same as that recommended for erysipelas. The diarrhœa and sweating are undoubtedly operations of nature, endeavoring to eliminate the poison. They should therefore be merely controlled, not arrested. As the fæces ought to be promptly removed, so ought the excretions of the skin. Washing and rubbing of the skin should not be neglected. See that the patient has plenty of pure air. Tonics and stimulants will have to form a portion of the remedial measures; indeed, in the more severe cases, upon stimulants will depend the chance of recovery. In chronic cases, it will often be found advantageous to have a change of air, scene, and diet.

The second class of poisoned wounds are inflicted by a healthy living animal. Of these it is unnecessary to speak. I am not aware of any animal at the present time in Canada, whose bite is particularly dangerous; although the sting of some bees is, for a time, very painful.

CHAPTER XXXI.

Third Variety: Hydrophobia—Two Kinds—Dog-madness—Symptoms—Three Stages—Symptoms in Man—Course—Diagnosis—Pathology—Period of Latency—Prognosis—Treatment.

Hydrophobia.—The third class of *poisoned wounds*—the only one of importance in this country—is hydrophobia; and the alarming frequency with which we hear of its occurring, and destroying life in the most distressing manner, calls for a careful consideration of the disease.

Hydrophobia is a disease generally communicated to man by the dog; which, entering the system in a single place, gradually inoculates the whole, and in course of time produces certain constitutional effects, which are characterized by certain well-marked symptoms. The ordinary way by which the virus is introduced, is by the bite of the rabid dog. The tooth is not itself poisonous, but the saliva is. In the secretions of the mouth resides the fatal principle of poison. The poison cannot find entrance through sound, unbroken skin; but when the tooth of the animal inflicts the wound, then the poison flows into it, and may be taken up by the absorbents. But any wound, it matters not how made; any sore; any abrasion; even a thinness of the integument, will sufficiently open a channel by which the saliva can, if brought in immediate contact, be absorbed, and thereby the poison in time infect the system. Cases are mentioned by writers, where the disease was contracted by a rabid dog licking the face, upon which were small pimples, or which had been cut by a razor.

Varieties.—Two kinds of hydrophobia are mentioned by writers, one of which is characterized by great rage, in severe paroxysms; the other, by not only an entire absence of rage, but, instead, a degree of paralysis. However, it is a question whether the latter kind is not the last stage of the former.

Origin.—Hydrophobia is supposed to arise spontaneously in the dog, and sometimes in the cat; also the fox, the wolf, the jackal, and the badger. Various causes have been assigned for the generation of the disease, especially in the dog. According to some, the extremes of heat and cold will produce it. But the disease does not prevail in either very hot or very cold climates. *Sudden* changes from extreme heat to extreme cold, or *vice versa*, are more likely to have something to do with it. Unsatisfied sexual desire is also supposed to be provocative of the *rage*. But the fact is, the origin of the disease is not understood.

Dog-madness.—Inasmuch as it is the dog that generally gives the disease to man, it is necessary to have some proper idea of the disease as it appears in that animal, and the symptoms by which it is characterized.

As in man, so in the dog, the symptoms are not always the same; yet the disease always goes on to a surely fatal termination. One of the first symptoms, in the dog, is a degree of rest-

lessness, and suspicion of every body and thing; even his own master will be regarded with a perceptible degree of fear. Instead of going as usual to his kennel, he seeks unusual places in which to lie. As the disease becomes developed, he will at times snap in the air, as if at flies. The eye becomes unnaturally bright and sparkling, so much as to seem reddish. It is not bloodshot; but rather like that of a wild savage animal in the shades of night. The mouth and throat soon become affected, the secretions of the mucous membrane thereof being abnormal—thick and tenacious. The efforts to dislodge this give rise to an unnatural barking.

The following is taken from the System of Surgery, and is derived from the writings of Virchow. He describes the disease in dogs as consisting of three stages, and in the following manner: "The first stage is the *melancholic*, and is often unnoticed and unrecognized at its onset; still, there may be observed a palpable change in the natural condition; alternations of depression and exaltation; restlessness, and change of place; sudden waking from sleep; irritability; deranged digestion; anorexia. The dog has often a greedy appetite, but sometimes leaves his food, or snaps at it. There is natural thirst, and no fear of water. After these premonitory symptoms have set in, the specific character soon becomes developed. There is great susceptibility in the cicatrix, when a bite or wound has been the antecedent; a change of affection, character, and desires; a proneness to lap his own urine, and eat the fæces of other dogs; a peculiar idiosyncrasy to take all sorts of unwholesome and indigestible things, such as straw, paper, wood, &c. There is much sexual excitement, and eager licking of the genitals of other dogs. He seems friendly with the cat, but exhibits a marked change of affection toward his master. He becomes shy and backward, and avoids observation. The organs of deglutition and respiration become involved. There are spasms, and difficulty in swallowing, as if something was sticking in the throat; alteration in the voice; arrest of salivary secretion; application of the tongue to cold surfaces, such as stone, iron, &c. Changes also take place in the motor system, for in all there is more or less debility and weakness.

"The second stage is the *irritable* and *furious*. It commences generally in from one to three days, but may set in after twelve

hours; it is seldom, however, met with after the eighth day. This irritation, the height of the disease, is not always uniform in its course. The paroxysms are strongest and longest at the onset, commencing with restlessness and irritability. He runs out of the house, attempts to bite, goes from place to place without thought or reason, endeavors to break his chain or destroy his kennel, and on his inability to do so increases in rage, and, if he gets loose, will run great distances. It is this proneness to bite which renders this period so dangerous. The paroxysms may last several hours, and often even a whole day. Then follows a remission, which is very deceptive, as all signs of disturbance subside; but the dog, aware of his unsociability, generally hides. The disease is often described from dogs who have been hunted, hooted, and followed about in the street, and goaded on to madness; and in these, severe symptoms are superadded, such as panting, and flow of saliva, outstretching of the tongue, thirst, dread of water, thrusting of the tail between the legs, starting of the hair, &c. The chief and prominent symptoms of this stage consist in psychical and æsthetic changes; there is a kind of acute mania and delirium, disobedience, no knowledge of his master, no avoidance of danger, sudden anger and snappishness, outbursts of wildness, loss of general sensation and all sexual feeling. The change in respiration and deglutition are: altered tone of voice, between barking and howling, indicative of extreme distress; swelling of the fauces, tongue, and nose. The movements of the body are rash and hasty, and the heart's impulse strong. The duration of this stage varies. It generally lasts three or four days, passing into the next and final stage; but in rare instances it may terminate suddenly in death, through a form of apoplexy.

"The third stage is the *paralytic*. The paroxysms now become weaker and remittent; the animal emaciates rapidly; the coat falls off; the flanks sink in; the hind extremities are weak and lame; he lies on one side in great prostration, but when roused is still snappish, and bites; if able to walk, he totters and drags himself along; the eyes are sunken and dull, the mouth open and dry, the tongue hanging out and hard, the heart's action weak, irregular, and intermittent, the breathing oppressed; convulsions may occur. Death takes place from exhaustion, or during a paroxysm, in from five to eight days from the first attack." This

description is so important and truthful, that it could not be abridged.

Frothing, to which so much importance is commonly attached, is due to the efforts to dislodge the tenacious mucus in the throat.

Symptoms in Man.—We have now to notice the symptoms of the disease in man. They are *local*, and *general* or *constitutional*. The wound in most cases will have healed, perhaps been healed for weeks, when the first uncertain constitutional symptoms begin to appear. But now, as a general thing, the part which had been wounded takes on inflammatory action; and if the wound has not healed, it assumes the appearance of an inflamed ulcer. There is redness and pain, which gradually extend toward the body along the course of the nerves. In the part will sometimes form a vesicle, in which will be collected a drop of serum-like substance. At the same time, a group of similar vesicles will sometimes form under the tongue, by the foramen. The fluid in these is said to be highly poisonous. An Italian physician entertained the idea that if these were duly opened, the disease would be aborted; but frequent experiments have proven the fallacy of his supposition. Nevertheless, it is recommended to carefully puncture these, and remove the contained fluid.

The *constitutional symptoms* are very slow in their development. In most cases, the patient, for an indefinite time, feels an indefinable indisposition—a dread of impending danger. If he be aware of the nature of the wound which he had received, he will be unwilling to entertain the thought of hydrophobia, yet it will force itself upon him. The mind very often becomes unusually active; the conversation will be brilliant and witty; the imagination vivid and flighty. Sometimes, on the contrary, he is melancholy and dejected. This state of mind, and these uncertain symptoms, may continue for several days; after which, the more characteristic symptoms begin to appear. Among the first signs will be those arising from embarrassment of the respiratory organs; at the same time the glands of the mucous membrane will pour out a secretion more copious and viscid than natural, which, adhering tenaciously to the surface, urges the patient to make extra efforts to expel it. These efforts are attended, in many cases, with an unnatural hawking noise. It is this which imagination has likened to the bark of a dog, and it has been supposed to be an attempt on

the part of the patient, while under the influence of the disease, to imitate the dog which had bitten him.

The paroxysms increase in frequency and severity, during each of which the mouth opens and shuts convulsively, which gives the patient the appearance of one snapping at objects. But this is not, as has been supposed, an effort on the part of the subject to gratify a rabid desire to bite. It is only the uncontrollable action of the muscles about the face and throat. Between the paroxysms, the patient is fully sensible of his condition; indeed, often, while the fit is on, he is quite aware of his state, but is impatient to resist the irregular action of the muscles. When the period of quietude is about to be followed by the rage, he will often give notice of the fact to his attendants. But the attack may be brought on suddenly, by any sudden alarm; and he is easily startled by an unusual sound or motion. At such times he will assume the attitude of defence, or as if about to deal a blow to some supposed foe. It is characteristic of this disease, in all animals, to make use, when alarmed, of the natural weapon of protection to the body: thus, the dog will bite, the cat will scratch and bite, the ox will use his horns, and man will use his fists.

The word hydrophobia indicates a fear of water; and the popular belief is, that any animal suffering from this disease will necessarily have this, as the most prominent symptom. But the fact is, fear of water, or any other fluid, is *not always present;* and when there is a dread of water, it arises from the insufferable pain which has been occasioned by efforts to swallow it. As the disease is developed, the tough, tenacious mucus, and the irregular action of the muscles, prevent the swallowing of fluids, while at the same time the thirst is distressing. It is a knowledge of the fact that the wished-for fluid cannot be swallowed, that causes the patient to shun the appearance of water, or any other fluid. Even the sound of water often produces feelings of great distress. Sometimes the mentioning of it will beget feelings of extreme terror; and also the sight of tears. But the patient will, for a long time, successfully try to swallow fluids; and when it becomes distressing, he will, as if anxious to show he has not the disease, use the most determined efforts to swallow draughts of water. Sometimes, in the height of the disease, the thirst will be so great that the patient will, with heroic determination, carry a cup to his lips, and

even succeed in gulping down large draughts of water. At first he may be unsuccessful, the cup being involuntarily drawn away; but after repeated efforts, the fluid will be swallowed, although mortal terror is in his countenance.

There will be, from first to last, occasional periods of fever and headache. There is often a pain shooting from the wounded part through the body, like that of rheumatism, and centring in the region of the heart. The penis is often in a state of erection, and there may be priapism, and seminal ejections. Vomiting is a common symptom, and entire loss of appetite; but sometimes the patient will be able to take food. Restless and easily excited at first, he becomes, toward the last, entirely wakeful, as if in utter despair, and is often exceedingly rageful. The urine is passed with frequency, and at last involuntarily. As the disease approaches toward the paralytic stage, all of the symptoms are intensified, until,—the strength of the patient being exhausted from the unnatural excitement, the terror, and the want of nourishment and drink,—depression, delirium, and paralysis supervene. "The pulse becomes small, quick, and irregular; the skin bedewed with clammy sweat; the eyes dull and sunken, and the pupils large; and death takes place, either from asphyxia during one of the convulsive attacks, or from exhaustion. The patient, however, may die quietly, sinking into a state of repose, with abatement of all the symptoms; in one case being able to eat and drink, and expiring immediately on suddenly waking." (System of Surgery.)

Its Course.—The disease will generally run its course in two or three days; it may, however, extend over a week, or eight days. As intimated above, the patient will generally die from exhaustion, and the duration of the disease will depend upon the powers of the patient to withstand the depressing effects of the disease. Sometimes death is hastened by some complication, as the arrest of the function of the lungs by congestion or paralysis. Occasionally, apoplexy suddenly closes the dreadful scene.

No two cases, probably, will be found to possess just the same features; but the disease may with propriety be divided into three stages. The first of which has the premonitory symptoms; the second is characterized by irritation and rage; the third by a tendency to paralysis. (System of Surgery.)

Diagnosis.—The only diseases with which hydrophobia may possibly be confounded are tetanus and hysteria. To distinguish it from tetanus it is only necessary to notice the character of the spasms. In hydrophobia they come on in paroxysms, while in tetanus the contraction of the muscles is constant. Instead of the irregular action about the throat, there is *continued* lockjaw.

Hydrophobia is sometimes simulated in hysteria. Fear of water is commonly supposed to be the characteristic symptom of the disease, consequently the hysterical patient has this as the chief symptom. While fear of water is very great, all the other symptoms of hydrophobia are absent. The history of the case, as well as the various circumstances existing in connection with it, will be quite sufficient to distinguish a true from a spurious case of hydrophobia.

Pathology.—The manner in which the system, some time after the bite, becomes affected, and the disease is established, is a question concerning which much has been written, and with regard to which there seems yet to be some difference of opinion. The poison is introduced into a part of the body. Attending the wound there is no symptom nor other indication of its deadly nature. The immediate results of the bite of a mad dog are in no way different from those inflicted by a dog not mad. The usual course is pursued by nature to heal the wound; restoration is, in most cases, as quickly and perfectly effected as in a wound not thus poisoned. Cicatrization is complete, the function of the part is in all respects perfectly restored. After an indefinite, but generally prolonged period, the average of which is forty days, the constitutional effects begin to show themselves; then, and not till then, the part wounded also manifests certain peculiar symptoms. What are the steps between the cause and the effect, which are so silently taken? Is it possible to trace the chain of morbid links which stretches over the interim of silence? Is the poison taken up by the absorbents; does it pass directly into the blood; and there, in course of time, become developed, as for instance in small-pox? Or does it act from the first upon the nervous system? Some pathologists hold one view, some the other. The local and general symptoms rather favor the latter. *Pathology* has not, as yet, thrown sufficient light to enable us to arrive at positive decisions on the above questions.

This disease differs very much from small-pox, and kindred diseases, in this respect, in that the period of latency is prolonged, and is unattended with any symptom whatever. This has led to the supposition by some, that a double zymosis takes place; first in the part wounded, by which the poison is increased or intensified so as to cause it to be taken into the system, and then having gained admittance into the blood, a second development follows, by which in due time, the whole volume of blood becomes affected. Probably, however, the other theory, that the virus acts solely upon the nerves, will prove to be the most in accordance with the nature of the symptoms.

The virus is received into a part of the body. Its effects are directly upon the nerves therein. Probably not creating, as Chelius supposed, a kind of quick running inflammation, but a disturbance somewhat analogous to it. In course of time, the length of which will depend, first upon the extent to which the poison is brought in contact with the nerve-tissue, or the intensity of the poison, and secondly, upon the strength of the constitution, and other circumstances, the disease of the nerves insidiously creeps along the nerve-trunk to the nerve-centres, and finally culminates in the spinal centre, or the medulla oblongata; and still working out its poisonous effects, causes abnormal reflex action in certain nerves, those especially about the throat; and hence the characteristic symptoms of the malady. From *post-mortem* examinations it is known that the medulla oblongata is principally affected. It is generally found softened. This softening sometimes extends to the striated bodies. The nerves which are most affected are the eighth pair, and it would seem that it is the morbid communication sent by these nerves, which produces all of the characteristic symptoms of the disease, such as the morbid condition of the mucous membrane of the mouth and throat, the abnormal secretion of the glands thereof, the unnatural condition of the tonsils; also the spasmodic action of the pharynx, the trouble in breathing, and the frequent paralysis of the lungs, the derangement of the stomach, &c.

There is great congestion of the encephalon, as might be expected from the terrific spasms of the disease. The blood is said to be more fluid than in health; the red corpuscles are broken

down, and the tissues are infiltrated by the unnaturally dark coloring matter.

Although much uncertainty exists as to the origin and mode of development of the disease, it is well known that it is propagated by inoculation through the agency of the saliva alone. "From experiments, it is proved that neither the blood, flesh, milk, seminal fluid, nor the breath, nor the secretions and excretions of the abdominal viscera, are capable of producing hydrophobia, although Magendie has endeavored to prove that the blood is contagious." (System of Surgery.)

Through the agency of saliva the disorder may be communicated by those animals before mentioned, among themselves, and herbivorous animals, to fowls, and to man. But the disease cannot be communicated at all by *herbivorous* animals, and there is no case on record where the disease was communicated by one human being to another. There is, however, a case recorded by Magendie, in which it was communicated to a dog by saliva taken from a man just before his death from this disease. This dog bit another, and both of them died.

With regard to the period of latency, it has been stated that the average time is about forty days. But a few cases are recorded, in which the disease was developed in a much shorter time, while, on the contrary, some cases are mentioned where the period extended over years. The case of the Duke of Richmond is sadly interesting, because of the fact that he was far away from home, in a half settled colony, and because that colony was Canada. His death occurred in 1819, and the disease "was attributed by his Grace to having had a cut on his chin, made in shaving, licked by a dog five years previous to the appearance of the disease. But it is much more probable that he was infected by a tame fox, which bit him through the thumb six or seven weeks prior to his death." (J. F. South, Chelius' Syst. Surgery.) And, with respect to all similar cases, there is a reasonable doubt whether there had been so long a period of latency. This question is one of some importance; for if the surgeon could assure one, who had been bitten by a rabid animal, that having passed a certain time without any signs of the disease, he was henceforth in no danger, it would be a great relief to him. And the fact, that we have not,

as yet, any very well authenticated cases, should warrant the surgeon to offer much comfort to the anxious bitten one.

Still more, there seems to be no doubt that now and then, an active imagination in connection with an exceedingly nervous person, may give rise to many of the symptoms of hydrophobia, and even lead to death, even when the dog which had bitten the person was not rabid.

These facts make it desirable that all reasonable grounds should be occupied to relieve the harassed object of a suspicious bite.

Prognosis.—The above-mentioned facts will receive their due consideration. It is an important fact, and one which ought to afford considerable comfort to the patient, that all of those bitten by rabid dogs, are not seized with hydrophobia. On an average only one in twenty go mad; and, when the anxious question is put to the surgeon, he may reply, that he stands a chance of twenty to one of not contracting the malady. Again, when two or more are bitten, the one first bitten is far more likely to become infected than those subsequently bitten. The saliva which is adhering to the mouth will be, to a great extent, wiped away in the first act of biting, so that when the next is seized, although perhaps more seriously wounded, there will not be present any quantity of poisoned saliva to enter the wound. And again, when the wound is not attended with much bleeding the danger is increased, as the blood when it flows from the wound, may wash away the fatal virus. For the same reason, a small wound, which naturally has limited hemorrhage, is more dangerous than a larger one, other things being equal. Bites upon the hand, or face, or other *unprotected* parts of the body, are more to be feared than those which have been made through a garment. When the tooth has passed through a thick, dense material, as the leather of a boot, there is very little cause to fear any evil; for the tooth would be completely cleansed of the saliva ere it reached the skin. All these points will be duly estimated by the surgeon, before he offers an opinion as to the *prognosis*. The most hopeful opinion should be expressed, and the ground upon which this opinion is based.

When the constitutional symptoms present themselves, the prognosis is most gloomy. A few cases are mentioned in which recovery, it is asserted, took place after characteristic symptoms had shown themselves; but it is to be feared that in these cases the ima-

gination had created the symptoms. What supports this uncomfortable view is the fact that, in all the instances of reputed cures, a subsequent trial of the same remedies has entirely failed.

Treatment.—The surgeon is always summoned in the greatest hurry; for, of all cries, there is none more alarming and electric than that a person has been bitten by a mad dog. He must needs accede to the most urgent of requirements. To him will be turned many an anxious face. And the patient should be seen as soon as possible, in order to take the necessary steps to prevent, if possible, the entrance of the poison into the system. Yet, in the interests of others, the surgeon ought to give the first attention to the animal supposed to be rabid. As we shall see, it is important to know whether the dog was actually mad. Inquiries ought to be made; and if the dog has not been already destroyed, care should be taken to preserve him alive, to see if it be really hydrophobia. This can be done in a judicious manner, without others incurring any risk. Dogs are frequently supposed to be mad when they are not. Any sickness or indisposition is likely to be regarded, by the apprehensive public, as that of hydrophobia; and no doubt many a poor cur is hunted, chased, and stoned, until he seems to be like one mad; indeed, he becomes mad in a certain sense, and, with frothing mouth, will in self-defence attempt to bite anything that obstructs his path. The surgeon ought first to determine, if he can, that the dog was really mad. The history of the case may reveal the existence of doubt as to the nature of the disease. But if the dog has been killed, all possible opportunity of deciding the question is forever gone; and there remains, for the patient and his friends, months, and perhaps years, of unnecessary but horrible suspense. If the person bitten be subject to nervous impression, we have seen that imagination, although it cannot beget the disease, may give rise to some of the symptoms, and even lead to death. Still more, there are not wanting those who believe the disease to be a disease entirely resulting from a busy imagination. Certainly, there can be but little doubt that it will at least aid in its development. In view of these facts, it must be conceded, that, not only in the interest of the public, but for the benefit of the patient, the dog should have a first consideration, and that its life should be preserved. For the bitten one, no other medicine would be required than a sight of the living dog after several days.

And should the dog unfortunately die, it will be no worse for the patient. But even then, all hope is not destroyed; many a dog dies with the symptoms of hydrophobia, due to other causes. Considering the very great influence the mind has upon the development, if not of the disease, at least certain symptoms of it, I have ventured, in the class-room, to suggest that if a dog like the one which had bitten the patient were shown to him, leading him to believe it the one by which he had been bitten, the disease might be averted. The terrible nature of the malady might justify the deception.

With respect to the patient, the great aim of the surgeon is to remove the virus from the wound before it can take effect upon the tissue or be absorbed. Those points referred to under *prognosis* will receive a quick but definite consideration, so as to estimate the probable degree of danger. Flowing blood tends to carry the poison out of the wound; bleeding should therefore be promoted. By sucking the wound, which can be done with impunity if the lips and mouth are unabraded, it is possible to draw out fluid containing the virus. A friend will generally be found to perform this important duty. When some time has elapsed since the reception of the bite, this mode of using suction will hardly suffice. The various measures recommended to prevent the entrance of poison in dissecting wounds, may likewise be adopted. But excision of the tissue around the wound is the most reliable step to be taken.

The virus is probably confined to the superficial part of the wound. The tooth of the dog, as it pierces the tissue, will be effectually cleansed of the saliva as it passes through the skin; and as the blood begins immediately to flow (and if it continue to flow), the poison cannot have found its way to the deeper part of the wound. Under such circumstances, the excision of the superficial part of the wound may effectually remove the poison. To insure a complete removal of the tissue all around the wound, it has been recommended to make a ring around it, by the application of nitrate of silver, before commencing the incision. It is better to remove too much than too little of the tissue which may be contaminated. Even when the wound is upon the face, the question of deformity—of unseemly scars—will hardly be taken into consideration. It is a question, not only of life and death,

but of a most horrible death. The dog being really mad, the face having been unprotected, the saliva of the animal was freely besmeared upon the face and the wound. The chances, then, are fearfully against the patient; therefore, the duty of the surgeon is plain. The face having been well cleaned, the tissue around must be effectually excised: no matter if the wound be extensive, no matter if it be upon the face of a female. Life first, beauty afterwards. When the hand, or a finger, or a foot, has been much mutilated, it will be safer to amputate the member at once. Sometimes the cautery is used, both actual and potential. The safer course is to excise, and then use the nitrate of silver freely. It is even recommended to excise the cicatrix after the constitutional symptoms have begun to appear. Respecting the propriety of such procedure, there is, however, some reasonable doubt.

Constitutional Treatment.—During the period of suspected latency, constant efforts should be made to tranquillize the mind, by relieving it of unnecessary apprehension. Unfortunately, when general symptoms have shown themselves, but little can be done. To palliate is the highest aim the surgeon can take. It is scarcely necessary to enumerate the long list of antispasmodics and sedatives which have been recommended, but subsequently found wanting in power to cure, although they may have power to give temporary relief. Among them are aconite, Indian hemp, musk, camphor, arnica, nitrate of silver, belladonna, hyoscyamus, &c. Strychnia, also, has been highly recommended. Many of these may control, somewhat, the distressing symptoms. The injection of warm water into the veins has been tried, but with no beneficial result. Ice has been used, also, to the spine, with the view of producing sedative effects, and it has proved serviceable for a time. Ice will be more grateful to the patient when given to him to take, in small pieces; these he can often swallow, with most comforting relief. Marshall Hall, while pursuing his unwearied course of observations on reflex action of nerves, conceived the idea that, in hydrophobia, the difficulty of breathing was the final cause of death, and that the operation of tracheotomy would prove a cure. However, by such a course, only one symptom is relieved. The disease always takes a steadfast course, whether one or more symptoms be relieved. The cessation of dyspnœa does not in any way retard the fatal course of the malady.

In conclusion, I have to refer to the proposed cure by salivation. A case is recorded by a Dr. Legget, of Maryland, who declares that he successfully treated a colored girl, aged twenty, of unmistakable hydrophobia, by the administration of calomel in drachm doses. Having first abstracted blood to the amount of ℥xxxij, he administered the drug about every six hours. Under this treatment, the paroxysms gradually subsided in force and frequency. The ground upon which he based the treatment, was that "the increased flow of saliva appears to be a conservative effort of the *vis medicatrix* to *eliminate the poison from the system*, through the glands engaged in its secretion." So far as I know, this remedy has not been fully tested. But it is to be feared that it, like so many others, will fail when again employed. Yet it is to be hoped that the advance of pathological science will hereafter enable the profession to conquer this distressing malady.

CHAPTER XXXII.

Tetanus: Symptoms—Stages—Pathology—Diagnosis—Treatment.

Tetanus.—Varieties.—There are two kinds of this disease, the Idiopathic and the Traumatic. It is the latter which the surgeon is called upon to treat. By tetanus is understood a tonic contraction of one or more of the voluntary muscles, commencing almost always in the region of the neck, especially the muscles of the jaw. Hence the cognomen *lockjaw*. It is essentially a nervous disease, in which the nervous centres, especially the medulla oblongata, assume a function decidedly morbid.

Its Nature.—It has generally been supposed that in *traumatic* tetanus some irritation in a certain part, commonly where a wound has been made, acts upon the nerves therein, creating a morbid action, which action is, after a time, communicated to the nervous centres; there in turn to establish an unnatural condition, which will be manifested by morbid reflex action,—the phenomenon above-mentioned, that is, an incessant contraction of certain muscles, which will continue for an indefinite period, but often until death

terminates the disease. This *has* been the general view; but of late the question has been raised, whether the nervous system would exhibit a condition so abnormal, and lead to a termination so frequently fatal, if there were not a previous constitutional derangement, or predisposition to disease. The fact that idiopathic tetanus arises without any apparent external cause, goes far to support this latter view, namely, that in order that the local irritation may produce the disease, there must have previously existed some specific disease of the blood, engendered perhaps by the development of some poison akin to that which gives rise to pyemia, erysipelas, &c. The following view may perhaps be advanced: A certain poison or weakness of the system may become the cause of certain effects upon the whole nervous system. This condition may remain in a latent state for an indefinite time. At last, however, there is an expression of disturbance, as manifested in *idiopathic* tetanus. Now, idiopathic tetanus is comparatively a *mild disease*, and rarely terminates fatally; at least, under favorable circumstances it runs a safe course, the morbid reflex action not passing beyond the bounds of recovery. But should the individual sustain an injury (while the system is in this vitiated condition), involving the peripheral nerves of a part, such as a severe laceration of their substance; then a morbid action is initiated, which gathers strength as it extends from the part to the nervous centres, and finally, by reflex action, culminates in fatal spasms and general exhaustion.

But whether one view or the other is received, that is to say, whether we attribute traumatic tetanus simply to a wound of a certain kind, or whether we believe some constitutional affection must pre-exist, there can be no doubt that the local injury gives a decided nervous character to the malady. While the idiopathic form may be recovered from, the traumatic rarely does. The former runs a slow, uncertain course, the latter a quick and decided one. In the idiopathic, or *chronic*, as it is sometimes termed, the muscles about the neck only may be affected, constituting *trismus*, or *lockjaw*. In the traumatic, or *acute*, the disease does not stop here, but quickly extends to the muscles of the body. When the muscles in front of the body are alone involved, and the body is bent with the head forward toward the feet, it constitutes *Emprosthotonos;* when those of the back alone are engaged, there is

Opisthotonos. Sometimes the disease attacks the muscles of one side, and then it is called *Pleurosthotonos.* And sometimes in its intensity, the disease affects all the voluntary muscles of the body, so that it is immovable—rigid. Here we have essentially *tetanus*—the disease in its perfect type.

Causes.—The causes, to repeat somewhat, are *local* and *general*, or *predisposing* and *exciting.* The general cause is some weakness or poison developed in the system. That weakness is a cause, is seemingly shown by the fact that the bleeding, or accidental loss of blood, sometime before the attack, will intensify the complaint. The local causes are wounds or injuries, especially such as involve dense fibrous structures, which have a free supply of nerves. In these cases the nerves themselves are generally lacerated, or otherwise very much irritated. There are certain irritants which seem particularly to possess the power to light up the disease, the embers of which had been laid. The rust of a nail, the accretions upon an old pin, are among the most active ones. Exposure to extreme heat and cold, are said to be exciting causes of the disease.

Structures subject.—While the disease is most likely to occur in connection with wounds of a fibrous structure, it may also follow wounds of the face, neck, joints, spermatic cord, as well as of the fingers and toes.

Period of Incubation.—The length of time between the reception of the wound and the commencement of the disease, is said to vary very much, indeed, from a quarter of an hour to a month. There are cases mentioned in Chelius of both kinds. When the disease presents itself, the wound may be yet in an inflamed state, or healing, or suppurating, or a cicatrix may have formed.

Stages—Symptoms of each.—The disease may be divided into three stages (Chelius), with corresponding symptoms. In the first stage the muscles about the neck only will be affected. There will be a sense of stiffness like that which accompanies a common cold. The larynx and muscles of the tongue are unable to act freely, causing the voice to appear unnatural. The efforts to swallow cause often great distress, and sometimes terror, especially when it is water, as in hydrophobia. It is these symptoms—the changed voice and difficulty of swallowing, which have produced, sometimes, difficulty of distinguishing the two diseases apart. There is an absence of inflammatory symptoms, but sometimes there

are shooting pains. In the part wounded there may be unhealthy action, or it may remain unchanged. After a time the stiffness of the muscles about the neck assumes the form of lockjaw; and the second stage is introduced. The mouth, now, cannot be opened, unless with great difficulty, either by the patient or surgeon. The lips appear thick, and frequently drawn down at the corners of the mouth. The eyelids are sometimes firmly shut, the iris contracted, the eyeball fixed, and there is an acute sensibility to light. This contracted state of the muscles of the face gives a most unpleasant expression to the countenance, which sometimes becomes hideous. The muscles of the abdomen are generally the next to become affected, and the intestinal canal, and other abdominal viscera participate in the affection; and there is, consequently, retention of stools, and of the urine. This constipation is almost always present; and it was asserted by Abernethy, that this constipation was the determining cause of the malady. Constipation generally precedes the tetanic convulsions, and Abernethy inferred and taught, that were the costiveness relieved in time, the disease would be averted. But the more generally received view of the present day is, that the deranged state of the prima viæ is the effect of the morbid condition of the nerves, and not a cause, or a link in the chain of causes. At this period of the disease there is more pain experienced; sometimes severely at the lower extremity of the sternum, extending back to the spine, probably arising in the diaphragm. Sleep is more or less disturbed, and often absent. The voice becomes indistinct, and swallowing almost or quite impossible.

The *third* stage is introduced by some difficulty of breathing; the muscles of respiration begin to participate in the spasms. Occasionally the contraction is so decided that death at once ensues, by the arrest of the respiratory function. Oftener there is great and continued distress of breathing. Death may be immediately caused by the disease extending to the heart. Sometimes the contraction of muscles about the throat is so great that the venous current is arrested, and thus death will be produced by apoplexy. But death is more frequently due to the spasms of the muscles of respiration. During the whole course of the disease, the intellect is but little, if any, affected. At the last the mind will be a little confused.

Pathology.—*Post-mortem* examinations have not revealed very much. The nerves and their sheaths, extending from the wound toward the spinal cord, are sometimes found inflamed. In the substance of the brain and spinal cord, but little, if any, change can be detected. They are sometimes congested, occasionally softened. (Chelius.) The membranes, however, are always found congested, especially those of the cord; possibly though, the gravitation of the blood after death, may assist in producing the latter condition. Effusion of watery fluid between the membranes is not uncommonly seen. Recent observations show that the medulla oblongata is generally softened. As yet there is not sufficient data to establish any hypothesis.

Diagnosis.—Hydrophobia is the only malady for which tetanus may be mistaken. But if the history of the case and the character of the spasms be studied, there cannot be a mistake. In addition, the diagnosis will be assisted by noticing the condition of the mucous membrane of the mouth and throat. In hydrophobia there is an undue viscid secretion; in tetanus such is not the case.

Prognosis.—In the traumatic form, it is always unfavorable. But few cases of recovery are recorded. The danger is always in proportion to the acuteness of the attack. If trismus only be present, and there be no tendency to increase in the intensity of the symptoms, then there is hope. This hope will brighten, as day after day passes away with no increase in the severity of the symptoms. South says "if seven days pass away, in any case, there is great hope of recovery."

Treatment.—The pathology of the disease, so far as understood, must be the basis upon which to found judicious treatment. It is essentially a nervous disease. The blood may be in an abnormal state, or other morbid conditions may exist, which have led to the malady. But when the disease is before the surgeon, he finds the nervous system principally affected. All along the nerve-tracks—from the seat of the wound to the spinal centres, and in those centres themselves, and then along the nerves proceeding to supply the muscles, which in this disease become affected, at many points and in a degree more or less intense—may be found irritation. No doubt, the greater the aggregate of irritation, the more decided the disease. Taking this view, it can readily be understood that every cause of irritation should be, if possible, removed; the irritated parts soothed; the whole nervous system soothed.

To fulfil the former indication, to remove the local cause of irritation, it has been recommended to remove or destroy the part in which the wound is situated. This has been done by amputating, or by cutting away the irritated tissue, and also by the application of the cautery. Again, it has been recommended to divide the trunks of the nerves leading from the part, by incisions, thereby severing the chain of causes by which the disease is supposed to be established. Such procedure can only possibly be attended with benefit in the earlier stages, before the nervous centres have become involved; and even then, if there be a constitutional affection, but little benefit can be anticipated. The propriety of using the cautery may well be questioned, as it will rather tend to increase than to allay the irritation. If any kind of cautery should be employed, the actual cautery ought to be selected, heated thoroughly, so as to completely and promptly destroy the irritated nerves. Sedatives of various kinds may be found very serviceable, when applied to the wounded part; perhaps may even prevent the general disease.

The Constitutional Treatment.—Efforts will be directed to allay the spasmodic action of the muscles, and to secure a healthy action of the excretory organs, and, in the meantime, to sustain the patient's strength. Bleeding was formerly practised, but with little advantage; indeed, loss of blood, it is seen, renders the disease more fatal. Cupping along the spine has been attended with more benefit, as well as incisions on each side of the spine. Purging, with croton oil or elaterium, ought to be secured as early as possible, assisted by injections, if necessary. Sedatives and antispasmodics of every kind have been tried, but with indifferent success. The system seems to have acquired a tolerance of drugs, so that these medicines are to a great extent inert, especially opium. Belladonna has been given, with a little yet no permanent success, in doses of one, two, and three grains of the extract. And there is a long list of other remedies, which have been recommended by different authorities: such as Cannabis Indica; tobacco, and warm bathing; colchicum; blisters along the spine, with sedatives to the raw surface; also ice along the spine; mercury; chloroform. But, whatever remedial measures may be resorted to, there is an absolute necessity for powerful tonics and stimulants. These must be freely and frequently administered, by mouth and per rectum.

DIVISION IV.

DISEASES OF CERTAIN TISSUES, BONES, JOINTS (INCLUDING FRACTURES AND DISLOCATIONS), ARTERIES, AND VEINS.

CHAPTER XXXIII.

Diseases of Bone: Remarks—Classification—Course to be Pursued—Inflammation of Periosteum—Of Bone—Causes—Symptoms—Local—General—Prognosis—Pathology—Terminations—Duration—Treatment of Acute—Chronic—Of Products—Fibrin.

Diseases of Bone.—Diseases of bone have their points of peculiar interest and importance, the principal two of which are: first, the fact that the bones constitute the framework of the system; and secondly, that they are quite covered up by the soft tissues. The osseous system is not only a framework, but a moving one; and the various muscles by which it is moved have their various points of attachment to the bones. Consequently, any injury or disease of the bone not only gives rise to local symptoms, but also interferes, to a greater or less extent, with the movements of the body. And again, the bones being hidden from view, it is more difficult to understand the changes which may be taking place in their structure. Therefore, the diagnosis has to be arrived at entirely from external symptoms and signs; and consequently, the surgeon, in treating disease of the bone, will have to give the more diligent heed to those points of diagnosis which are discernible.

Classification.—Various classifications of the surgical affections of the bone might be given. It is better, however, to select that which is most practical—which will, by cognomen and arrangement, afford to the student some assistance, not only to avoid unnecessary repetition, but to simplify the subject.

In considering inflammation of the bone, it is desirable to refer,

in the first place, to the periosteum and endosteum. Although these membranes are, strictly speaking, fibrous in their nature, yet the fact that they are the textures in which are spread out the feeding-vessels of the bone, and because, when in any way affected, they are so likely to cause disease of the bone itself, renders it difficult to describe the affections of one structure without, at the same time, those of the other.

Following the course pursued in the consideration of the general principles, I shall, in course, speak briefly of *inflammation of the periosteum*, and the products thereof; and then the more remote results, viz.: *effusion of serum; of lymph; suppuration; inflammation of bone; necrosis; hypertrophy; induration; atrophy; softening; caries;* also of *tubercle in bone; cancer; aneurisms; tumors; wounds of bones;* and finally of *fractures.*

Inflammation.—As before intimated, the relation between the periosteum and the bone is most intimate; consequently, it is most difficult to say, in most cases, whether the disease is in one tissue or the other, or both. Indeed, the disease is very likely to extend, by contiguity, from one to the other. The usual division into acute and chronic may be made; yet, in many cases, the inflammation assumes the form of the subacute. Indeed, the inflammation, when situated in the bone proper, although acute, resembles, both with respect to its course and the symptoms, the chronic inflammation of soft structures. Calling to mind the phenomena of inflammation, this will be readily understood. Although the bone, like other tissue, has within it bloodvessels, whose function it is to carry blood to and from the osseous fibres, and has absorbents, and is supplied with nerves and cellular texture, yet, from the dense and firm nature of the cellular structure, it is impossible for the same changes to take place which are seen in inflammation of the soft tissues. In fact, the inflammatory process is less rapid in its course, and less certain in its results. Because of these physiological facts, it was formerly supposed that inflammation never occurred in the bone. But the advance of pathological knowledge has placed these diseases on a proper basis.

Causes.—The causes of inflammation of the bony structure and its membranes may be divided into general and local, or into predisposing and exciting. As a general thing, the intensity of the inflammation corresponds, in an inverse ratio, with the power of

the predisposing cause. That is to say, when the constitutional cause is the principal actor in begetting the disease, the inflammation will not be so acute; while, on the contrary, when there is but a slight predisposing cause, a more potent exciting cause being required to create the morbid action, the inflammation will be much more severe.

Constitutional Causes.—The most important constitutional causes are syphilis, mercurial poison, scrofula, impoverished state of the system, from long continued exposure to cold and wet, with insufficient food. Two or more of the general causes will often be found coexisting. When the patient's system is at the same time vitiated by syphilitic and mercurial poison, there seems to be not simply an addition of the two poisons, but as it were, a multiplication of them.

Local Causes.—Are injuries of various kinds, as blows, lacerated wounds extending to the bone, contusions, fractures, continued pressure, inflammation in neighboring parts, passive congestion, resulting from improper position of the limb and interrupted venous flow.

Symptoms, Local and General.—The ordinary *local symptoms* of inflammation, pain, heat, redness, swelling, are present; but all of them are not equally well marked.

Pain is always present, and in the acute form is always most intense. The cause of this intense pain will be obvious, when it is remembered that the bone, and also the periosteum, are unyielding, and that consequently the irritated nerves will be subject to great pressure, as the tissue becomes congested, and the products of inflammation effused into the structures.

Pain, indeed, is so constant and so severe, that it constitutes one of the diagnostic marks of the disease. The pain, always acute, at night becomes exquisite; this is a further diagnostic symptom. At all times, the slightest pressure made over the part will cause the most excruciating pain.

Heat is never very great, and may be absent. *Redness*, in the first stage is generally very slight, unless the bone involved is subcutaneous. On the contrary, the skin is often unusually pale; but as the inflammatory action continues and extends, the superimposed integument, however deeply seated the bone may be, will become gradually red. In many cases the redness is due to the

presence of *venous* blood. *Swelling* at first is not very perceptible, yet there is a tense and full condition of the skin, which may be detected on close examination by the eye, or the finger. This is due to effusion of serum in the subcutaneous cellular tissue.

The *general symptoms* are well marked. The very great pain quickly creates constitutional disturbance and inflammatory fever, with all its concomitants (*vide* Inflammatory Fever). But other constitutional symptoms not unfrequently attend this disease, especially in the chronic form. These symptoms may indicate some predisposing cause of the disease, and will be due to some taint or faulty condition of the blood. In the more chronic form, there is often great debility of the constitution, characterized by a bloodless condition of the skin, emaciation, loss of strength and spirits, want of appetite and sleep, and, when the patient is sinking, there will be hectic.

Diagnosis.—As already observed it is impossible, in most cases, to decide whether the periosteum or the bone is involved, and hence *periostitis* and *ostitis* have been considered as one disease. But, while it may be impossible to decide whether the bone or membrane is the seat of disease, it is important to understand the several stages of the disease, and to distinguish between a state of inflammation, and a state due to the results of the inflammation, more especially of caries. Other affections, for which it may be mistaken, are rheumatism and gout. But by duly considering the history of the case, as well as the local symptoms, the surgeon can hardly go astray in his diagnosis.

Prognosis.—This must be very guarded; at the best the disease is often tedious, while it may be followed by the most serious consequences to the bone, recovery from which will be anything but rapid; yet, as a general thing, the disease is not fatal to life.

Pathology.—In every disease of the bone, whether it be inflammation or the result of inflammation, a correct knowledge of the pathology is of essential importance. The surgeon ought fully to understand and watch for the various changes which may occur in the progress of the disease, and, as accurately as may be, the several symptoms by which each pathological state is characterized.

When the inflammation is established in the membrane which covers the bone, or which lines the canal within, or in the bony

tissue immediately in contact with either of these membranes, an event may suddenly occur, of great pathological interest, by which the bone is exposed to serious danger; this occurrence is due to a rapid effusion of serum, the first product of inflammation, between the membrane and the bone, so as to forcibly separate them, and thereby to destroy the numerous small nutrient vessels by which the bone is supplied with blood. The natural result will be death, or necrosis of the bone, which had, through the membrane, been supplied with blood; and then must follow a long tedious process of sequestration by nature. Again, the product of inflammation, poured out, may be liquor sanguinis. If sufficient in quantity, it will also produce similar immediate results; and when this is not the case, destruction of the bone may follow by a more protracted course. The liquor sanguinis may, of course, be absorbed; but often while the serum will separate from this compound and be absorbed, the fibrin will remain to become organized, or it may degenerate into pus; in the former case the coagulation and contraction of the fibrin will tend to destroy the tiny vessels. Many of them may be embraced, as it were, and perhaps completely strangulated, by the fibrin contracting around them. When many of them are completely strangulated, necrosis inevitably follows. But the vessels may be only embarrassed, so that normal nutrition is impossible, and the remote consequence will be a diminution of the osseous fibres. And the weight of the bone, although the general bulk is in no way changed, will also be lessened. This is called atrophy. This disease may be due to other causes, but in this way it may arise as a result of inflammation of the bone, or its periosteum.

Then, the inflammatory lymph, in whatever place poured out, may, instead of coagulating, degenerate speedily into pus, or degenerations may follow ineffectual efforts to organize. Pus thus formed at once constitutes an acute abscess, which will be attended with well-marked symptoms.

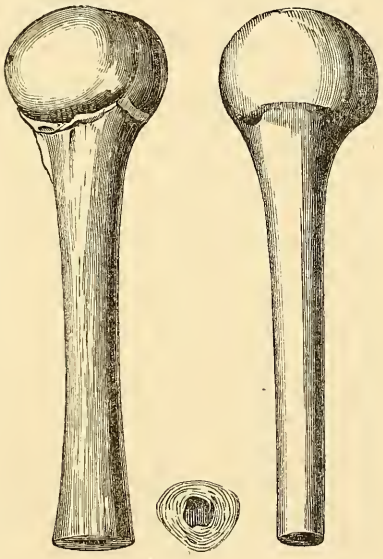
But the lymph, instead of existing between the membrane and bone, may, as a product of periostitis, be effused in the substance of the membrane, or upon the outer surface of the membrane; or it may simultaneously exist in both places, and, perhaps, at the same time, in the bone. Wherever it may be, however, there will follow organization, or degeneration. Sometimes the organization

is accomplished gradually. This is, now and then, seen in chronic periostitis, or when the inflammation is subacute. The effusion and organization are occasionally circumscribed; more frequently when the disease is due to syphilis. There may coexist in different places (in this constitutional affection), perhaps in different bones, several periostial thickenings. They are known by the name of syphilitic *nodes*. The plastic matter, between the membrane and bone, may undergo a very perfect development, so that the two will become so incorporated that they are indistinguishable. But at any time during the process, degeneration may supersede development, and be followed by death and disintegration, not only of the adventitious material, but as well the original tissue in which the effusion had taken place. In this way extensive and formidable destruction often occurs in the progress of constitutional syphilis, constituting tertiary symptoms. I have observed them very frequently on the bones of the head and upon the tibia. (*Vide* Syphilis.)

When the inflammation involves the bone proper, we will meet with other changes than those just described. In the course of the first stage (active congestion), although there is no swelling externally in the soft parts, there is actually swelling of the bone. It soon loses its natural density, the interstices of the bone being occupied by the products of inflammation. The vessels in the bone being engaged, gives a bright red appearance. As the effusion gradually increases, the osseous fibres are separated, and thus the bone is literally swollen. The separation of the fibres may cause a rupture of the vessels, so that here and there will exist small clots of blood. This state continuing for some time, the osseous fibres, constantly pressed upon, will be gradually absorbed, so that the body of bone will be left soft and spongy. If at any time the inflammatory process be arrested, the fibrin which has been effused into the widened interstices, if not speedily coagulating, may be absorbed, leaving the bone *atrophied;* or, on the contrary, the adventitious matter may become organized and incorporated with the normal tissue, causing *induration*,—another disease of the bone. But, the bone being swollen at the time the fibrin becomes organized, there results not induration alone, but also *hypertrophy*,—yet another disease. And, when a long bone is almost, or altogether inflamed, the swelling attending will cause *lengthening*,

as well as thickening. This hypertrophy, although spurious, is seemingly complete. Should there, however, be no swelling when the coagulation of fibrin commences, there will be simply induration.

The adventitious matter may in time be superseded by natural bony tissue, and if there has been no swelling, the recovery will be complete; but if there should have been swelling, then the bone (when the natural shall have superseded the adventitious) will be truly hypertrophied. When, however, the fibrin which occupied the swollen bone is shortly removed by the absorbents, it will leave the bone unusually large, although *atrophied.* Again, the liquor sanguinis may continue to occupy the interstices until the osseous fibres are almost entirely absorbed; in which case, when the inflammation subsides, the bone will be found *softened:* a condition which may continue, there being insufficient power in the bone to recuperate. Thus, it will be seen that the inflammatory process may terminate in any one of mostly all of the more important diseases of the bone, and that a comparatively little thing may turn the disease from one course to another.



Nature will put forth her efforts to repair the bony tissue when diseased; but it often happens that these efforts are unsuccessful, the result of which is a condition of the bone analogous to that which is observed in the soft parts when the healing process fails. This is called *caries.* The fibrin, which was intended to act a primary part in the process of repair, fails in its duty, and perishes in the attempt to perform it, and, at the same time, very often involves the original tissue in its own destruction. Two or more of the above diseases may coexist in the same bone; and, occasionally,

there may also be seen one or more of those diseases in a part, while in another part nature may be successfully effecting repair.

In conjunction with caries, when efforts are being made to repair, there will sometimes be, instead of natural healing of bone, bony deposits in an abnormal form, in shape of growths; these are called *osteophites*. Or it may be upon the periosteum, constituting *exostosis*, *soft* or *hard*. The same deposit may take place upon the endosteum, or even in the canals or the lacunæ; in either case it may be like the natural bone, or it may be *ivory-like*.

It may be stated, as a general fact, that mostly all of the diseases of the bone which come under the notice of the surgeon are due to the inflammatory process, and the efforts of nature thereafter to heal.

The *terminations* of *periostitis* and *ostitis* may be classified as follows:

1. Resolution. 2. Organization of plastic matter, which has been effused. 3. Degeneration of it into pus. 4. Partial development of the adventitious matter, and subsequent death and disintegration. 5. Necrosis. 6. Softening. 7. Induration. 8. Hypertrophy. 9. Atrophy. 10. Caries. 11. Bony growths. 12. Exostosis.

Length of Time.—The length of time required for the inflammation to run its course, will depend upon the intensity of the disease. The acute form may terminate in a few days, in one way or another; but when one of the other diseases follows as a result, the course is always tedious. The chronic form is slow from the beginning.

Bones most Liable.—The bones of the body most liable to inflammation are those which are exposed to injuries and the weather, as the tibia, ulna, clavicle, sternum, and cranium.

Treatment of Acute Periostitis.—First, the local. Bearing in mind that the pain is great, and the cause of that pain, the first step to be taken is fully indicated. In the first place, there must be absolute rest, and due attention paid to position; then every endeavor used to allay the pain—to remove its cause. Immediate resort should be had to *hot fomentations*, either alone or in conjunction with *anodynes*. When the bone is subcutaneous, the effect may be very prompt and satisfactory. They must be diligently employed. Occasionally, a *hot poultice* may take the place

of the fomentation. The tendency of these applications is to relax the dense tissue, and thus, directly and indirectly, soothe the nerves. The effect is produced through the cutaneous nerves. *Cold*, as a sedative, is sometimes employed; but its efficacy is not so certain as that of the hot applications. Sometimes, local abstraction of blood is necessary; this may be done by *leeches*, or by *incisions*. In the earlier stage of the disease, leeches will suffice; but afterwards, the incisions may be necessary. *Blisters* have been recommended; but in the acute form, they will more likely aggravate the disease—at the least, the using of them will interfere with, or take the place of other agents of more certain value. In the mean time, measures will be taken to subdue the constitutional fever. Endeavor to get the various *excretory organs in healthy working condition; reduce the heart's action; observe low diet;* and, according to some authorities, *exhibit mercury*—instead, however, I should recommend the nitrate of potash, or the iodide. The treatment must be prompt, inasmuch as the disease runs a speedy course, and disastrous results may quickly follow.

When the pain, although it has already been severe, suddenly becomes more intense, with a corresponding increase of the other symptoms, there is reason to suppose that *effusion* has taken place *between the membrane and bone*, and it becomes the duty of the surgeon to promptly relieve this condition. Fomentations or abstraction of blood *will not suffice;* there must be a *subcutaneous incision indirectly made to the bone*, so as to incise the periosteum, and thereby allow the pent-up effusion to escape into the cellular tissue around the bone. By this procedure, necrosis of the bone may be averted. The incision does not require to be very large to allow the effused fluid to escape. It will soon heal by adhesion.

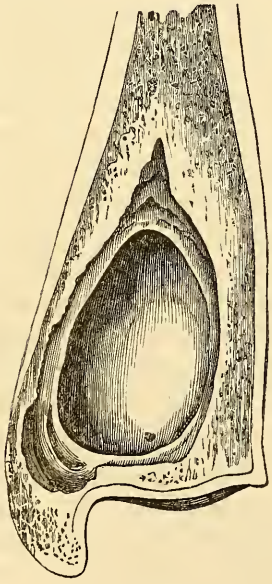
Treatment of Chronic Periostitis.—The treatment thus far has referred especially to the acute form of the disease; but in many cases, the periostial inflammation is more or less *chronic*. In such cases the treatment will be less heroic, but none the less decided. In every case, however, it is equally important that full attention be given to rest and position. The constitution being generally at fault, it must from the first receive *specific* attention. The peculiar taint which had acted as a constitutional cause of the disease,

must obtain that particular attention which its nature demands. Local abstraction of blood will not commonly be required; but should acute symptoms present themselves, which will occasionally happen, then the treatment suitable thereto will promptly be adopted. But as a general thing, the treatment will consist of *counter-irritation*, *blisters*, or the *application of the tincture of iodine*. The iodine is more particularly useful in certain stages of nodes. It acts as a stimulant somewhat, and creates a more healthy action, which, superseding the chronic inflammatory action, assists nature to remove the adventitious matter which has been deposited. The constitution must be invigorated by proper dietary measures, as well as by attention to those principles detailed more particularly in connection with syphilitic disease.

Treatment of Remote Products.—In the treatment of organized plastic matter—a more remote result of inflammation of bone and the membranes—the surgeon will duly consider what is the probable amount or extent of those results; what has been the effects upon the tissue; and what has been the nature of the efforts made by nature to repair; and to what extent they have been, and will probably be, successful. The lesson has already been learned that, by natural steps, repair may be effected, and the products of inflammation either removed, or so modelled that the tissue will be restored to its normal usefulness. But in the bone, just as the inflammatory process is slow in its course, so is the subsequent reparative process; yet, at the same time, the work is being accomplished in a perfectly healthy manner, and no art can possibly accelerate the operation. The duty of the surgeon will consist as much in seeing that too much is not done, as well as in administering to the actual requirements of the case. I have too often seen a second and fatal attack of inflammation produced by injudicious efforts to promote the removal of the organized products of ostitis and periostitis. The bone in which it is placed is often but little able to resist the effects of this second attack of disease, and caries may very quickly ensue. Nothing is more likely to give rise to this than overstimulating applications; or hot applications, after inflammation has subsided. Counter-irritation may occasionally be cautiously employed; but the principal indications are a maintenance of rest and attention to the constitution, with a view of insuring healthy action. When the bloodvessels of the

bone are much impaired, the footsteps of nature will be very slow, and the surgeon can but wait. There are, of course, certain medicines which do act upon the absorbents, and which, it might be supposed, would hasten the removal of the adventitious matter; but it must be remembered that the normal bone is incapacitated for quick action, and no drug can cause it to perform extraordinary work in the process of repair. Again, mercury has been recommended, with the view of producing liquefactive degeneration of the organized material. That it may have such an effect, there can be no doubt; but the danger is, that the effects of the drug will not be limited to the adventitious matter, but that it will also destroy the feeble natural tissue as well. There are too many cases in which destructive caries have thus arisen, which have come under my own observation, to allow me to say one word in favor of mercury in such cases.

Treatment of Degenerated Fibrin, in connection with Bone.—First, of pus. It may collect in the form of an abscess, between the bone and periosteum; in the substance of the bone; or in the medullary canal; and it may be the result of periostitis, or ostitis, or of both. The symptoms of acute abscess are generally well marked; the pain, particularly, is very great, and nothing less than an incision will do. It must be made *directly* down, and sufficiently large to allow a free discharge of the pus. This will be easily done when the pus is between the membrane and bone; but when it is collected in the osseous structure, or in the medullary canal, it will be more difficult to perform; yet the same course must be pursued, provided the location of the abscess is known. The acute abscess is mostly superficial, while the chronic is more frequently deeper seated. In the latter case, the symptoms are not so well marked, and the diagnosis is less cer-



tain; but there is not the same urgency to operate, either on account of the pain, or the danger to the bone or the patient. In acute abscess, the formation of pus will be indicated by the great pain becoming, for a time, even greater; then a slight subsidence, and at the same time a chill. In chronic abscess, there is no such reliable indication of suppuration. Although there is pain, which is often severe, it is not so exquisite, and it comes on gradually; also, the pain is not always in the same place, causing it sometimes to be taken for rheumatic pain. It is more of a dull or aching character, and gives a sensation of being deep-seated. The history of the case will afford assistance to arrive at a correct diagnosis. When chronic suppuration takes place in bone, it is generally after some injury, or an attack of inflammation which had entirely subsided. Although convinced that there is pus, there remains the difficulty of deciding the question of locality. The operation consists in making an incision with the knife to the bone, and then in using the trephine to cut through the osseous tissue. If pus be not discovered, it is recommended to use the instrument a second time.

Treatment, where there is partial development and then molecular death—disintegration.—This is found to occur in constitutions of a low or cachectic character. The fibrin, originally possessed of but little vitality, quickly coagulates, and soon thereafter perishes; but before it dies, it may have caused serious injury to the nutrient vessels, and to the tissue in which it was effused. This adventitious matter not only dies, but it leads to molecular destruction of the tissue in which it has been deposited. There is ulcerative destruction. This form of disease is often seen, not only in scrofulous constitutions, but also in the case of syphilitic nodes, more especially about the cranium. The only thing to be done in the way of treatment, is to treat the constitution generally; endeavor to renovate it; in the mean time, using such local applications as will tend to limit the ulcerative process and facilitate the work of detachment of the diseased bone from that which is sound. In these cases, the stomach may be unusually sensitive, indicated by a poor appetite and inability to digest food. This organ will have to be coaxed, under such circumstances, by using light farinaceous food, with beef tea and oysters, &c. All of the organs of the body may be weak, and require due attention.

Sometimes the pain in the part is very distressing, especially in nodes upon the cranium, necessitating the administration of anodynes. The bowels must be kept regular. As to medicines, the various preparations of iron will be found beneficial. But the iodide of potassium will prove to be particularly useful; it deservedly enjoys a high reputation in all such diseases. Mercury, which formerly was exhibited in these cases, is in most instances decidedly contra-indicated. There is already a want of vitality; there is already a disintegration of tissue, both of the natural and the adventitious; and more than that, there is often extensive destruction in consequence of the use of this drug. Therefore, no medicine which tends to lessen vitality can with propriety be administered. There will arise cases in syphilis in which mercury may be given, but they are quite exceptional. (*Vide* Syphilis.) The *local treatment* will depend upon the condition of the part, and will be based upon principles laid down in the treatment of chronic ulcers.

CHAPTER XXXIV.

Necrosis: Kinds — Sequestration — Symptoms — Treatment. Softening of Bone: Kinds—Rickets—Diagnosis—Treatment. Hypertrophy and Induration of Bone—Atrophy—Causes of Each.

Necrosis, or Death of Bone.—This, as has been elsewhere fully described, may be the result of periostitis, or ostitis, accompanied by effusion; or of destruction of the bloodvessels, caused by coagulation of fibrin around the vessels, or of laceration of the vessels; or from injuries, by which the periosteum is stripped off the bone; indeed, anything which cuts off the supply of blood necessary to life in the bone. The result is *death*, not gradually taking place, but at once; not in molecules, but *in a mass*, more or less large. The nutrient vessels which have been destroyed may be in the periosteum alone; and supposing it to be a long bone, the portion of bone which dies will be in the *outer portion* of the shaft. This will constitute *external* necrosis. Or the vessels affected may reside in the endosteum, when the effect will be death of a portion

of the *inner part* of the shaft, constituting *internal* necrosis. But sometimes the vessels both within and without the shaft are destroyed, in which case there will follow death of a portion of the *whole shaft*. This is called *complete* necrosis.

Those bones which are dense in structure are more readily deprived of life than those which are more cancellous in structure, these latter being more subject to caries. Certain portions of the same bone are often predisposed to necrosis, and other portions to caries, for the same reason.

When a portion of bone dies, the mass, although thereafter to be a foreign body, necessarily remains, for a time, in a condition resembling almost a state of nature: that is to say, the osseous fibres of the dead bone are continuous with those of the living, and the character and appearance of the dead portion do not quickly change. Steps, however, are soon initiated to effect a separation of the living from the dead structure, and in due time a line of demarcation is established between them. The line of separation, however, is by no means uniform; all of the osseous fibres do not divide at the same point. Consequently, when the dead bone is completely sequestrated, there will be seen, on every side, spiculæ of bone projecting, with corresponding depressions. The process by which this separation is accomplished by nature is most interesting and instructive.

At the commencement, in the immediate neighborhood of the lifeless bone, active congestion will be seen to exist. Seemingly, the blood which was intended to support bone now dead, but in which it can no longer circulate, fills to repletion the cancelli of the neighboring bone, and even the canaliculi will be found engorged with fluid. This, which is the first step in the inflammatory process, is the first step also to secure sequestration of the dead bone. In consequence of the congestion, the osseous fibres will begin to soften at the point where vitality ceases. The fibres pressed upon are steadily absorbed, until the work of dividing them is completed. This absorption must be, in the main, if not altogether, at the expense of the living bone. Possibly some of the dead tissue may be acted upon chemically where the structure is softened, but it must be very limited in quantity. It is stated, however, by a recent writer, that more of the dead bone is absorbed than has been supposed. (System of Surgery.) The

action by which the work is done can be accomplished under physiological rules; that is, the congestion need not exceed a point beyond which the accruing lymph could not be preserved from degeneration into pus. At the same time, not unfrequently pus is generated, and occupies to a greater or less extent the space which exists between the dead and the living portions. In other words, the sequestration may be done by physiological action, and therefore without any real pain, or anything to indicate the action. But in other cases, the congestion is so great as to cause effusion of lymph, which, unable to become organized, degenerates into pus. This latter method may be considered pathological, because it is not necessary to the fulfilment of the work. When pus is a product of the action, the separation is the more speedily effected; but there will be attending it many of the symptoms of ostitis; and still more, there will be more extensive destruction of the living bone. Whether the action has been physiological or (the congestion having merged into true inflammation) pathological, the *sequestrum*—for that is the name given to the fragment *after the separation is completed*—will act as a foreign body, and give rise to irritation and that sort of inflammation which is always created to expel any foreign body, whatever its nature. In many cases, the disease which has led to necrosis will have been inflammatory, as we have seen; and pus may have been the immediate result thereof. In such cases, it may be expected that the process of separation will also be attended with some suppuration. However, as there will be an opening through which the discharge may escape, there will be an absence of the symptoms of inflammation. But oftentimes this channel will become closed, and the pus collecting will give rise to all the symptoms of abscess.

In the case of external or complete necrosis, the sequestrum will at once tend toward the surface of the body. The sharp spiculæ of bone will at every motion of the limb produce irritation; which will very soon give rise to suppuration, and if an opening to the surface do not exist, an abscess will form, which upon being opened will disclose to the surgeon the foreign body seeking, as it were, its exit from the body. It will, in the abscess, have been borne somewhat outward. The pus having free exit, there will be following the sequestration, the process of repair upon the surfaces of the bone from which detachment has been effected. This work

at repair often commences before separation is complete. In fact when there is not inflammatory action, the work of actual repair may be going silently on at the time the fragment is being dissevered. As soon as the new bony tissue does begin to form, there will commence a constant pressure upon the sequestrum, by which it will gradually be forced toward the surface. These are the agencies by which nature will endeavor to rid herself of the foreign body. It will be seen that although separation of the bone may be effected without suppuration, the sequestrum cannot exist without producing it—that it is indeed necessary to expel it from the body. But the surgeon ought to assist nature. Until separation is complete, the only duty of the surgeon is to see that nature is allowed to work unembarrassed. The channel from the surface to the sequestrum, through which it can be examined, is called the *cloaca*.

The above are the simple but efficient steps by which the sequestrum is expelled in the external and complete forms of the disease. But in case of *internal necrosis* the work is by no means so easily accomplished. The dead bone is incased in the living, through which an avenue must be made, that it may be released. To accomplish this nature is often adequate. This living bone which encircles the dead, will be more or less softened by the process of sequestration; and if inflammation attend, which is not unlikely, ulcerative destruction of the surrounding bone may take place so as to effect an opening. At all events, when the detachment is completed, the foreign body will provoke inflammatory action, followed by softening of the surrounding shell of bone. The process of softening occurring in one or more places, the pus which is pent up will escape into the external soft tissue, and in time, from the body. Through these channels nature will essay to expel the sequestrum. When the dead bone is of large size, it cannot possibly find exit, and will remain for an indefinite period of time, causing a most disagreeable (though not necessarily a painful) purulent discharge. From time to time the sinus may close, upon which the pus will collect, giving rise to pain and uneasiness, which will be followed by a reopening of the abscess. In time, the inclosed sequestrum *may* disintegrate, under the influence of heat and moisture; but the process is very slow.

When there is complete necrosis, that is when a portion of the

whole shaft is dead, as soon as the dead bone is separated from the living, and even before, the limb may be incapacitated for use. But nature takes early steps to meet this, and to supply a substitute. The congestion which causes the separation, also leads to the deposit of bony matter all around the shaft. This will continue to form until a very *complete case will surround the necrosed bone*. When this condition is produced, there is a close resemblance to internal necrosis; for this shell of bone may become very hard, even harder than original bone. While the shell of bone is thus forming, there will remain a number of openings through it by which the discharge will continue to take place. By the formation of this case of new bone, the shaft will become considerably larger. During the progress of these somewhat complicated proceedings, there will be, from time to time, a good deal of local pain and constitutional irritation.

Sometimes the death of bone upon the surface will be so limited that merely a thin scale will be separated; this is commonly designated *exfoliation*.

Symptoms of Necrosis—Diagnosis.—There will have been some injury, or inflammation, the symptoms of which need not here be repeated. Those symptoms manifested in connection with the history of the case, will assist in arriving at a correct diagnosis of the disease. Necrosis has been divided by writers into three stages: the inflammatory, the stage of detachment, the stage of reparation. Many symptoms of each of these stages have already been adverted to in connection with the pathology. When the necrosis is the result of inflammation, and there is as yet no opening externally, there may be some obscurity in the diagnosis. Necrosis may be suspected, or feared, but it cannot be positively known. But if the dying bone is accessible to the eye, or by the probe, the condition characteristic of death may readily be detected. When it has resulted from an injury, in which a wound has been made in the soft parts and the periosteum stripped off, the eye can easily discover the first changes toward death. When the formation of an abscess precedes the existence of a cloaca, then, as before said, the surgeon must wait until a way is open for the probe. The sound, or sensation produced by the probe striking the dead bone, cannot be mistaken by the educated surgeon. The sound is of a ringing nature, similar to that produced by striking it against a

skeleton bone. Another reliable symptom is the nature of the discharge. In a pure case of necrosis it is composed entirely of laudable pus; if there be anything else it will be arterial blood, which has escaped from the forming arteries which have been lacerated by the spiculæ of bone, or the probe introduced by the surgeon.

The surgeon has to determine, by the symptoms, not only that necrosis exists, but also the extent, and the stage of the disease; whether sequestration is nearly, or quite consummated. It is important to know when the separation is finished, because until then the surgeon cannot materially assist; he must wait until nature has done her work. The indications by which this shall be determined are such as the probe alone can reveal. In most cases there will be two or more openings, which, generally, are some distance apart, perhaps on opposite sides of the limb. By passing a probe down to the bone it may be at once felt to move, revealing the fact of its separation. Sometimes a second probe, introduced in another place, and then the two manipulated together, will reveal the fact of separation. Possibly the sequestrum, although quite detached, may be immovable; this will result from the granulations of new bone becoming so intertwined among the spiculæ of dead bone, that the fragment is very firmly fixed. In such cases the surgeon would wait until sufficient time had elapsed to remove all doubt.

Treatment of Necrosis.—Already it has been seen that nature promptly proceeds to detach and throw off the dead bone; and although the process is slow, yet in the healthy subject it is always successfully accomplished. While this work is being done, the surgeon can but control any tendency to excessive action, and palliate any aggravating symptoms which may present themselves; also any tendency to constitutional disturbance; or, if necessary, afford support to the strength. No interference can hasten the process, nor is it allowable to remove by instruments bone which is not yet detached; the line of demarcation is uncertain, and the surgeon might remove more bone than is doomed to perish; or on the other hand, he might not remove enough. When, however, sequestration is completed, then there should be no delay in undertaking its removal. Heretofore, nature only could efficiently work, now the surgeon should relieve her of further efforts which

she will strenuously make to accomplish what lies beyond her legitimate bound of duty. In external necrosis the bone may be gradually carried toward the surface of the body; but it is slowly done, while by the surgeon the fragment might very easily be extracted. In case of internal and incomplete necrosis, the only way by which the unaided powers of nature may expel the bone, is by the open sinuses through which the detritus of the sequestrum can be carried out, after it has disintegrated by chemical action. When the fragment is large the time will be distressingly long before the extrusion can be accomplished. During the period of separation some of the dead bone may come within the power of the absorbents; but subsequently it is a foreign body, beyond the influence of animal life. And, while it is thus quite, or altogether impossible for expulsion to be effected by a natural process, the constant irritation to and drain made upon the system will expose it to great danger. These are cogent reasons why no delay should be made in removing the sequestrum.

The knife need not be always used to remove a sequestrum. Very often the fragment may be extracted by forceps, introduced through the sinuses. This may be happily accomplished when the fragment is not great in length. Sometimes, again, the dead piece may be divided by small pliers introduced, so that extraction can be done by piecemeal. When the sequestrum cannot thus be removed, the knife will have to be resorted to. The operation now will consist in, first, making an incision through the soft parts to the bone; and secondly, through any bony structure that may compass the sequestrum; and lastly, the extraction of the bone. The division of the soft parts must be sufficiently extensive to allow the second step to be taken advantageously. With respect to the second step—the division of bone—it is important to remember that the earlier the operation, the more easily will the bone be divided, as it is more soft. After sequestration, any surrounding bone, whether new or old, will become even harder than natural bone. I have seen not a few cases—one quite lately, my own patient, involving the femur—in which the greatest force was requisite to divide the ivory-like bone. When the bone is quite soft, it may be divided by a strong knife; but in most cases the trephine or chisel, and often both, will be required. The first aperture made by the trephine may be sufficient to allow the ex-

traction to be made; but a second application may be necessary, perhaps a short distance from the first, and then the intervening piece of osseous substance may be chiselled out. The trephine should, if practicable, be applied at the extremity of the sequestrum. No more of the sound bone should be touched than is absolutely necessary to make way for extraction of the dead bone.

The sequestrum being removed, the operation is completed. The bone around may seem to be unnatural in appearance, perhaps softened; but in a pure case of necrosis, it will be found that the removal of dead bone will rapidly be followed by a perfect healing of the bone. There must be no gouging as in caries; even manipulation of the bright red tissue should not be practised. Having removed the dead bone, and the bleeding having ceased, it will be well to place a piece of wetted surgeon's lint in the wound of the soft tissues, to prevent adhesive union. The healing must go on primarily at the bottom, in the bone; and should the soft parts close before the bone has healed, the formation of an abscess will most probably result. In most cases, the recovery is quick and perfect.

Softening of the Bone.—There are several causes to which this may be due. It may involve a part or the whole of a bone, or the whole osseous framework. Certain forms of softening may come on at certain periods of life. Rickets is a disease peculiar to childhood. Mollities ossium comes on in adult life, occurring more frequently to the female. Fragilitas ossium has been by some regarded as a form of softening; but it can scarcely be so considered.

Mollities Ossium.—"The disease which appears best to deserve a separate description, under the name of mollities, is marked by the following characteristics: Several bones are usually affected at the same time. The portions of bone attacked are uniformly softened, throughout the whole extent of the disease. The disease, however, does not in all cases affect either the whole length or the whole thickness of the bone; and if the specimen be examined at an early period, the outer shell is often found to retain its natural consistence. When the whole bone is affected, it can be readily bent, and resembles, in extreme cases, as Dr. Ormerod remarks, rather a portion of fatty matter inclosed in a case of periosteum, than a bone. If the cancellous tissue (in which the

disease appears to originate) be examined, it is found that the cells are enlarged, sometimes to such an extent that the whole bone is expanded, and are filled with a peculiar reddish gelatiniform matter, in which, on microscopical examination, much fat and oil can be discovered, together with blood-disks. Besides these (which are the common products of any degenerative change), certain peculiar nucleolated nuclear bodies have been described by Mr. Dalrymple. Instances of bones affected with mollities ossium do, however, occur, in which the amount of fat is not greatly increased." (Syst. Surgery.)

It will be seen, from the above, that true mollities ossium is a degeneration of the bony tissue. We have seen that a degree of softening attends the inflammatory process, and that a long-continued congestion, with effusion, will lead to absorption of the bony fibres. The degeneration called mollities ossium may be a more remote result of the inflammation.

Causes.—All forms of softening may have their causes divided into general or local. The general may be hereditary or acquired. Rickets, a disease of childhood, is unlike mollities, in this respect: that it much resembles scrofula, and is hereditary. The true mollities ossium, although coming on later in life, is most frequently the effect of a constitutional depravity, which may have been immediately induced by a local cause. Repeated pregnancy is said to be an exciting cause.

Result.—In rickets, under suitable treatment, the disease may often be cured. But before this is effected, life-long mischief may have been done; the bones, being more or less bent, may have become natural *in consistence and strength.* There may consequently result deformity of the limbs and of the spine, or a change in the form of some of the cavities of the body. In the thorax, the heart and lungs may be incommoded. But a more common evil result is to be witnessed in the pelvic cavity of the female, whereby parturition may be rendered difficult or impossible. True mollities ossium, being a species of degeneration, as well as coming on later in life, is much less amenable to treatment. The bones being flexible, motion of the body is impaired, or perhaps impossible, and the person will be exposed to all the evils of the system attendant upon inactivity. Exhaustion is likely to ensue; and in most cases, though not always, life will be short-

ened. Both in rickets and mollities ossium, when the osseous fibres are made brittle by change, numerous fractures may take place in the bones, from muscular action. It is this occasional symptom which has caused the disease to be confounded with fragilitas ossium.

Diagnosis.—Softening of the bone bears resemblance to *atrophy* and *cancer*. But the history of atrophy will be found different from that of mollities ossium. And also with that of cancer: its origin is unlike that of softening. Moreover, the cancerous disease is more limited in its nature.

Treatment of rickets is essentially the same as that prescribed in scrofula. (*Vide* Treatment of Scrofula.) Mollities ossium, unfortunately, is not often cured. Much may be done to palliate the helpless condition—to make the patient comfortable. By position, the tendency to deformity may be somewhat counteracted. The strength must be supported.

Hypertrophy and Induration of Bone.—In these diseases, the bone may be simply denser and larger; that is, the osseous fibres, although normal, are more numerous, and placed closer together; or the disease may be due to a deposition of fibrinous matter within the interstices of the bone, which, becoming organized and incorporated with the bony fibres, gives to the bone greater consistence and size. The cause of this latter condition is generally inflammation, followed by exudation of lymph. Continued irritation may be sufficient to induce unusual growth.

Treatment.—These may not be considered pathological conditions, which will give rise to peculiar symptoms; and their removal will mainly depend upon the complete cessation of the cause, and the slow but often effective powers of nature. The administration of iodide of potassium may possibly hasten the return of the bone to health; also the local application of iodine, friction, &c.

Atrophy of Bone.—As before explained, in this disease there is not any diminution in volume of the whole bone. The atrophy is in the individual fibres of the bone. As to the manner in which inflammation leads to this disease, *vide* Pathology of Inflammation.

Causes.—May be enumerated as follows: Inflammation; injury; degeneration; old age; failure of nutrition; long-continued confinement from illness; obstruction of the medullary artery.

There is no special symptom to indicate atrophy of bone, nor is there any particular treatment. (Syst. Surgery.) But the removal of the cause, when the disease is suspected, should be attempted.

CHAPTER XXXV.

Caries: Pathology—Causes—Symptoms—Diagnosis—Prognosis—Treatment—General—Local—Operation—Tubercle in Bone.

CARIES.—*Pathology.*—This is a disease quite distinct from necrosis, although the two are frequently confounded. To have a correct idea of its pathology, the student must understand that the morbid state arises from a series of efforts to restore bone which had become impaired. It is a disease of the healing process, analogous to ulcers of the soft parts. When, from any cause, local or constitutional, nature fails to heal a lesion in the bone, then will follow the disease of caries. And the same causes which lead to unhealthy ulcers of the soft parts also lead to this affection of the bone. Caries may follow almost any disease of the bone. Not unfrequently it is a sequel of inflammation of the periosteum and bone. It may coexist with or follow necrosis, as well as softening and induration. Remembering the analogy between caries and unhealthy ulcers, it will be understood there may be varieties. As to ulcers are given the names of weak, scrofulous, syphilitic, &c., so in caries the same names may be appropriately applied. But while caries resembles ulcers generally, it more frequently partakes of the character of the *weak* and phagedenic. In the majority of cases, there exists too much blood in the part; this blood is venous in character, and therefore wanting in the necessary elements for repair. There will be some arterial blood entering the part, but not enough to supply material for healthy healing. The fibrin, imperfect in character and vitality, goes not on to healthy organization. The granulations, struggling to grow, may attain to a certain standard, but life fails before the bone is at all mature. The material by which repair

was attempted not only perishes, but it constitutes a disintegrating substance, which will corrode the base—the living bone—from which the granulations had sprung. By this means, the disease, due at first to the imperfect character of the fibrin, gradually extends to the adjacent bone, which primarily had been unaffected. This invasion, by the disease, of new territory, will be attended with symptoms of inflammation extending to the soft parts, and by the formation of an abscess containing imperfectly elaborated pus, admixed with venous blood, and the *débris* of reparative material and of bone. After a period of much pain, which will be terminated by a discharge of the abscess, a fresh effort will be made to restore the bone, and perhaps the attempt may prove successful; but very often there will be a repetition of the morbid steps, the effort again resulting in a signal failure, and, at the same time, in a still further extension of the disease. Thus, it will be seen, caries is a disease of the healing process in bone. These fruitless efforts may continue for weeks and months, and even years. Now and then, perhaps, under favorable circumstances, successful restoration may be for a time made; but this will be followed by a return of the disease, and continued extension of the morbid process. This continued local irritation and disease cannot but impair the constitution, perhaps permanently. It will gradually become exhausted, and in time, if no relief be obtained, sink under the protracted irritation.

This, briefly, is the pathology of caries—a condition quite different from that of necrosis, and one, also, which must be distinguished from softening and ulcerative absorption, whether interstitial or progressive. At the same time, it must be remembered that two often coexist—that, indeed, caries may exist with almost every other disease of the bone.

Causes.—These have already been referred to. There are two general varieties: *constitutional* and *local.* The former are such as affect the whole system—the blood. These may have been inherited or acquired. The more important are scrofula, syphilis, mercurial poison, and debility from any cause. The principal local causes are injuries and inflammation. When there is a powerful predisposing cause, only a slight exciting cause is necessary to produce the morbid action.

Symptoms.—Will depend, to some extent, upon the course of

the disease, and will be modified by the extent to which the disease exists, and whether any other affection accompanies it. After a bone has suffered inflammation or an injury, should there be a dull, deep-seated pain, which displays a tendency to extend along the bone, there is reason to fear that, instead of the healing process being consummated, caries is commencing. Accompanying the first step in the disease is generally a diffused swelling of the soft parts, not very great in any one part, but spread over some extent of surface. At first the integument is unchanged in color; if there be any change, it is an unusual paleness. After a while, when pus begins to be formed, the skin will present a livid red appearance. I have sometimes seen it resemble, very closely, erysipelatous inflammation. Should the inflammation be very great, of course the pain will be correspondingly great. The pus, instead of being circumscribed, will be diffused in the subcutaneous tissue, perhaps even beyond the neighborhood of the diseased bone. Ultimately, the pus will secure an opening externally, though the process of pointing is very slow, as in diffused suppuration. Often there are several collections of pus, to each of which there will be an opening, and from which there will be, afterwards, as many sinuses, through which the diseased bone may be examined. The discharge from these sinuses is generally offensive, as might be expected, from the fact that there is death and disintegration of tissue. The pus is ill-conditioned, thin, and admixed with blood. This discharge, coming in contact with the surrounding tissue, will prove highly ichorous. The space of time over which these symptoms will spread themselves varies very much, but frequently it is weeks or months.

The constitutional symptoms may be divided into those which precede the local disorder, and those which are the result of the local disease. Of the former, sufficient has already been said. Respecting the latter, it will at once be apparent, when it is remembered that the disease is exhausting and prolonged, that very great prostration must follow this disease of the bone. The system, previously below par, is still further reduced, and very often death is the result.

Diagnosis.—The local symptoms, already given, are to a great extent characteristic; they are very unlike those of necrosis, or other diseases of the bone. The discharge from caries, especially,

is quite dissimilar from that of necrosis. It is, however, by the probe that the surgeon can the most fully satisfy himself as to the nature of the disease. In the first place, the mouth of the sinus, in caries, is different from that seen in necrosis. It has a hard, bluish, livid border, and often there is an excrescence sprouting up. Upon passing the probe into the sinus, it will not meet with any solid obstacle. A little force will be sufficient to pass it through the fragile and soft bony granulations, breaking down the delicate vessels which are engorged with venous blood. Hence it is, that when the probe is thus used, there will be a free *venous hemorrhage*. The probe, when it reaches the bone, is not arrested by a solid substance, as the sequestrum of necrosis, nor yet as healthy bone. But little effort is required to penetrate the diseased structure. The probe may be passed in different directions, but here and there meeting with the more solid bone. This condition is so characteristic of caries, that the surgeon cannot easily be mistaken. The diagnosis, however, may be embarrassed by the presence of necrosis in connection with caries; yet even then, the history of the case, and the nature of the discharge, with the revelations of the probe, notwithstanding the sequestrum, will enable the surgeon to arrive at a correct opinion.

Prognosis.—This will depend upon the condition of the constitution; the age of the patient; his position and circumstances in life—that is, the comforts at his command; and the original causes of the disease. The coexistence of two or more unfavorable conditions will naturally aggravate the case, and render recovery less hopeful. When the constitutional cause is scrofula, the prognosis is more doubtful. Also, when the disease is located near a joint, there is danger of complication. When of long standing, the disease will, as a general thing, prove less tractable, from the fact that the system has become depraved and exhausted. Again, when the diseased bone is naturally spongy, and when the disease involves several small bones which are placed closely together, as the carpal and tarsal bones, the result will be more doubtful.

Treatment.—In all affections of the bone, care should be taken to prevent this disease, more especially when there exists any predisposing cause. The requisites for the successful healing of bone must, if possible, be secured; for it must not be forgotten that caries is a disease of the healing process. The treatment

naturally divides itself into that which is directed to the constitution, and that which is applied to the part. As in other affections, the stage of the disease as well as the intensity, will modify the treatment. Speaking generally, the constitutional treatment will consist of such measures as will correct existing evils in the system, and as will aid in the formation of healthy blood for the work of repair in the bone.

In treating locally, the aim should be to restore and maintain the part in a state as natural as may be possible. When inflammation arises it will have special attention, and when pus is forming, a free exit for it must be secured. Emollients will, at times, be useful, but they *must not be continued too long*, as they will increase the passive congestion. One matter of great importance is to keep the part perfectly clean. The constant discharge may at times render this difficult. The dressing ought to be light and frequently renewed. The access of air to the part, so long regarded as dangerous, can do no harm, and often it will act as a healthy stimulant. And if the air could be, by any possibility, a source of evil, it could not prove so injurious as the contact of bandages saturated with the unhealthy discharge.

The pus mixed with the *débris* is often highly irritating, and if allowed to remain upon the surrounding integument, cannot but produce a greater amount of inflammation. The sores should be dressed at least once a day, and the skin around be thoroughly washed with castile soap and water, and then made quite dry. The beneficial effect of this alone is often very great. Indeed, in a large number of cases, *cleanliness*, *rest*, and *position*, will be sufficient local treatment. Stimulating injections are sometimes used, with the object of promoting healthy granulations. Iodine is a great favorite. After a good deal of experience in these cases, I must say that these injections rarely accomplish any permanent good.

Not unfrequently, although the general health may have much improved under constitutional treatment, and many local measures have been usefully employed, yet the disease does not show any disposition to abate. In some respects there may be an improvement, yet on the whole there are no signs of a cure. This will be in consequence of the very extensive mass of disease, so great that physiological action cannot seemingly supersede the patho-

logical, and permanent repair is not effected. In such cases to wait, is to unnecessarily expose the patient to pain and danger. The only course to pursue is to remove the diseased structure completely. Attempts are sometimes made to destroy the carious bone by the use of caustics; but they will act very uncertainly, not reaching every part affected, while destroying the healthy texture. The better way is to employ the knife and the gouge.

Operation.—The operation, as in necrosis, consists in dividing the soft structures which overlie the diseased bone to a sufficient extent, and then in removing every portion of the carious bone.

There is this important difference between the operation in caries and that for necrosis. In the latter the principal difficulty is to so expose the dead bone that its extraction may be effected, the removal itself being easy enough. And when the sequestrum is taken away the operation is completed. Not so in caries. The diseased bone can always be easily enough reached, but not quickly removed. There is no regular line of demarcation between the diseased mass and the sound bone; and while it is necessary to take away all of the former, it is very desirable not to injure the latter. The large quantity of venous blood with which the part is engorged, gives rise to copious hemorrhage, and this will render the operation tedious at least, and often will prevent that ocular examination which is desirable. As a general thing, the surgeon must trust to the sense of touch, rather than to sight, and the educated finger is a good guide. It will not be difficult to distinguish the sound bone from the unsound. The removal of the soft and carious bone *must be complete*, otherwise the process of repair might still fail. Generally the gouge will suffice to cut away the disease in its various directions; but occasionally the saw may be advantageously employed, excising a portion of the whole shaft, or a part of the body of the bone. A saw is always preferable to pliers, because the latter, before dividing the osseous fibres will crush and thus injure their vitality, and thereby subsequent healing is seriously endangered.

The carious bone completely removed, the cavity will be filled with oiled lint, that the process of healing may begin at the bottom. Caries sometimes attacks bones which are beyond the reach of the knife and gouge, as the vertebræ. In such cases the powers of nature must be supported, trusting to her wisdom, to employ

her energies aright. Rest of body and mind will be diligently secured. And counter-irritation, perhaps in the form of a moxa, will often, by diverting nature, enable restoration to take place. The kind of moxa which I have found serviceable, is one of gum camphor shaped to the form of a cone. This, placed over the seat of disease, is surrounded by a piece of cotton, and then fired. The result is a circumscribed eschar, and in a day or two an issue. By placing peas in the space the issue will be continued.

Tubercle in Bone.—The tubercular matter may be diffused in the cancelli, the lacunæ, and in the canaliculi, or it may be collected in the form of a distinct tubercle. It is very likely to result from irritation, inflammation, or injuries. The presence of the morbid element in the bone is very likely to give rise to a low form of inflammation, and subsequently to caries. The disease is commonly seen in the tibia, about the knee-joint, and in the bones of the cranium. Not a few cases have come under my notice among scrofulous children, where a fall upon the bone had been followed by deposition of tubercle. This would lead to the formation of an abscess, and subsequently a carious state, which would prove difficult of cure. As to *treatment*, it is unnecessary to repeat what has been said in connection with the general principles of scrofula.

For Tumors of Bone, Cancer of Bone, and Aneurism of Bone, see those diseases respectively.

CHAPTER XXXVI.

Fractures: Definition—Causes—Bones most liable—Classification—Variety of Displacement—Causes—Symptoms of Fracture—Diagnosis—Mode of Examining—Prognosis.

This last surgical affection of the bones which has to be considered is one of common occurrence, and is naturally very interesting. The office of the surgeon, when called to a case of fracture, is to restore the broken bone to its natural position, and avert deformity. A slight deviation of the fragments in their

natural relationship will mar the symmetry of the body, and, to a greater or less extent, incapacitate the part for its natural function; and the surgeon is expected to so arrange the fragments that no deformity shall exist after union. Any neglect or ignorance on his part will likely lead to failure in securing the desired end, and, at the same time, to his disgrace. The grave may conceal the mistakes of the physician, and also of the surgeon, in most other affections, when those mistakes lead to death; but an error in the treatment of fracture, and also of dislocation, will not destroy life, but remain living witnesses against the practitioner. Cases will often enough occur, in which deformity will ensue in spite of the best treatment, without the number being added to in consequence of culpable ignorance or neglect. Inasmuch, then, as the injury is of frequent occurrence, and the issue one of great importance—not alone to the patient, but quite as much to the surgeon's character—it is necessary that the student should give to the subject the most earnest attention.

It is scarcely necessary to define the term fracture; it is well understood to mean a *violent* division of bone into parts. The bone is not cut; it is broken by violence, directly or indirectly applied.

Causes.—May be divided into *predisposing* and *immediate.* The predisposing causes may, again, be divided into *local* and *general.*

Local Predisposing Causes.—First, the *situation* of a bone may render it liable to fracture, from its being exposed to injury. And the *function*, also, may expose it to that accident; for instance, the radius, from its relation and function at the wrist joint, is a bone frequently broken; also, the clavicle, whose function it is to retain the arm in the most useful position, is subject to injury when the body falls upon any part of that extremity. *Local inflammation*, and *other diseases*, will often so weaken the bone as to favor breaking of the osseous fibres.

General Predisposing Causes.—A large number may be mentioned. Peculiarity of diathesis, as *syphilis*, *mollities ossium*, *fragilitas ossium*, *rickets*, *gout*, *scrofula*, *cancer*, *scurvy*, *mercurial poison*—indeed, any exhausting or low disease. And old age is a predisposing cause. The fact that the bones become more and more brittle as age advances, after maturity, makes it intelligible

why this surgical affection is most likely to occur in the aged. Not only is the bone more brittle in those advanced in life, but such persons, also, do not possess that muscular power which is often called into requisition to save one from falling. Fractures occur more frequently in winter than in summer; not because the bones are then more brittle, although that has before now been taught; but because of the benumbing influence of the cold, especially upon the old. Then, at that season the earth is hard from frost and ice, and every one is more likely to lose his equilibrium, and fall upon the hard, resisting ground. The *male* is more subject to fracture than the female, from the fact that he is more exposed to injuries of every kind. *In old persons*, however, fractures are said to occur *more frequently in the female.* Several of the foregoing local and general predisposing causes may coexist.

Immediate Causes.—Of these there are two: *muscular action* and *external violence.*

The bones more frequently broken by muscular action are the *patella*, *os calcis*, and *olecranon.* Others are, however, sometimes broken. On this subject, Hamilton, in his most excellent work, writes as follows: "These accidents imply generally some conditions of the bones themselves which predispose them to fracture; but I have seen one example of a fracture of the shaft of the femur, in a large and perfectly healthy man, occasioned by a twist of the leg in rolling tenpins. I have also known the tibia and patella to break, from natural muscular action, in persons of uncommon vigor. Fractures sometimes occur in the violent contortions of the muscles during convulsions, and where no abnormal condition of the bones could be assumed to exist. Parker, of New York, relates a case of fracture of the humerus, in a negro preacher, which occurred in the act of gesticulation; also, a fracture of the clavicle, occasioned by striking a dog with a whip; in another case, the humerus was broken in attempting to throw a peach; but the most singular case of all was a fracture of the humerus, caused by an effort to extract a tooth.

"Nearly all of the cases of fractures occasioned by muscular contraction, seen by me, were transverse, or nearly so, indicating, perhaps, also, the existence of some unusual fragility."

The *external violence* may be *direct* or *indirect.* For example,

the clavicle may be fractured from a blow received immediately over the bone, or it may be from a fall upon some part of the arm, the force being transmitted to the part most easily broken.

Bones most liable.—The bones of the body *most liable to fracture* are the long bones. The bones of the leg support the body, and those of the arms are constantly called into use as levers, and so both are exposed to injury. Moreover, the great muscular power by which these limbs are moved must necessarily jeopardize the bones upon which they act. On the contrary, the broad, flat bones, from their situation and function, are comparatively safe from injury. To this general rule, however, the bones of the cranium must be excepted; these, for obvious reasons, are very liable to fracture. Short bones enjoy immunity from this accident.

Fracture of long bones may take place at any point, but it is most frequent at or about the middle. The reason of this is obvious. The bone will be bent until it breaks, and, like a rush, will yield first in the middle, unless some other part be more weak. But when the violence is directly applied, the fracture will generally be at the place struck.

Classification of Fractures.—I shall give several divisions, as stated by different writers, because it will afford instruction in the important principles under consideration.

The first is into *complete* and *incomplete.* That is, the bone may be entirely divided, or it may be bent almost to breaking: as the tough sapling is sometimes bent until some of the fibres are divided, although the trunk is not completely severed. When any of the osseous fibres remain undivided, it is designated incomplete fracture. This kind is more common in the young, when the bone possesses less of the harder elements of bone. Recently, I have had under my care an incomplete fracture of the radius, with complete fracture of the ulna, about two inches from the wrist joint. The lad was in his eighth year. Playing in a barn, he fell to the ground, and struck upon the hand. It was the most perfect case of incomplete fracture, and was, with comparative ease, bent back to the original form.

A *second division* is *based upon the direction of the fracture.* According to this division, there is the *transverse*, the *oblique*, and the *longitudinal* fracture. Bones which are brittle are gene-

rally broken transversely; hence the kind of fracture, in old persons, known as the pipe-stem fracture. Longitudinal fracture is generally due to direct violence, in connection with which there is generally comminution of the bone.

A *third division* is *based upon the appearance* which the fracture presents. Thus, we have fissures, stellated fracture, indented fracture, &c.

A *fourth division* is *based upon the character of the displacement.* In the first place, there may be no displacement, although the fracture be complete. When displacement attends, it may be *longitudinal;* that is, the ends of the fragments will override, and the limb be shortened. This form of displacement is more generally seen when the fracture is oblique. It may, however, be due to considerable force, by which the displacement is produced. Again, the displacement may be *lateral;* the broken ends do not come fairly together, one being to one side of the other. *Rotary displacement* is when one fragment is turned on its own axis; the displacement is in the circumference. *Angular displacement*—when the two fragments so come together as to form an angle, more or less. *Impacted fracture* is where the two fragments are driven into each other. The force which produced the fracture, or perhaps some other power, forces the fragments together—the osseous fibres of one among those of the other. Sometimes the union thus effected is very firm. The relationship of the pieces may be natural, but very often there is some displacement. The bones in which impaction most frequently occurs are the femur and the humerus, at their necks.

In connection with this subject, it is necessary to state that the *causes of the several forms of displacement* are capable of a useful classification. Thus, there is, first, *external violence*, which violence may be the force which produced the fracture, or it may be some other subsequent violence, direct or indirect. Or the displacement may be due to the *weight of the limb or of the body* in falling, after the injury is received. Also, during the process of removal of the patient, the weight of the limb, with the *muscular contraction*, may produce displacement. *Muscular contraction is alone a frequent cause of displacement.* The muscles attached to the fragments are irritated, and, in consequence, contract spasmodically; and the lever being broken, there can be no harmonious

action of the whole—instead of which, the lower piece will be often brought into a variety of abnormal positions. It is necessary, however, to notice here, that sometimes the muscles are benumbed and paralyzed, so that, from their action, displacement is impossible.

Another division of fracture is into *simple*, *complicated*, *compound*, and *comminuted*. By *simple* fracture is understood a breakage of the bone with no other lesion, and followed by no subsequent inflammation. By *complicated* fracture is meant a condition in which there is something more than a fracture. The complication may be local or constitutional. Among the local complications are severe bruising, wounds, injuries to nerves and vessels. Constitutional complications are such as may tend to excessive exhaustion, or inflammation, or in any way to interfere with the process of repair. A *compound* fracture is a complication; but, because of its comparative frequent occurrence, as well as importance, it receives a special notice. It consists of a wound with the fracture, by which the fractured ends communicate with the air. A wound with a fracture simply does not constitute what is understood by the term compound. This wound of the soft parts may have been produced by the object which came in contact with the body, when producing the fracture, or it may have been caused by the falling of the limb or the body, so as to force a broken end through the soft parts. Subsequent inflammation, and the formation of an abscess, may open a passage to the broken bone, and thereby beget a compound fracture.

The term *comminuted* fracture is applied when there are two or more fractures of the bone. The idea generally associated with the term is a breaking of the bone in several small pieces, by some direct violence, perhaps actual crushing of the bone.

Symptoms of Fracture.—There are a variety of symptoms, some of which, being physical signs, are excellent diagnostic marks, while others are only important when taken in connection with the former. *Pain* is a very common symptom, and is very severe; yet similar pain may be the result of other injuries and diseases. Pain, in connection with fracture, is generally due to the spasmodic twitching of the muscles, by which action the sharp broken fragments are forced into the soft tissues or nerve trunks. There are often exacerbations of the pain. In those cases where the

muscles are paralyzed, there will, of course, be an entire absence of pain.

Loss of voluntary motion is another symptom. The bones are moved in a state of nature on the principle of the lever; when, therefore, the bone is broken, effectual motion of the limb cannot be made; the patient has no control over it. But there may be loss of voluntary motion from other causes. The nerve may be injured by a bruise or a wound; consequently, simply loss of power to move the limb does not always indicate fracture. *Swelling* and also *ecchymosis* may be given as local symptoms, but they, like the forementioned, exist often in connection with other injuries.

Unless the fracture be a very simple one, there will be some constitutional disturbance. But the general symptoms, like the above-mentioned local ones, are not reliable diagnostic marks, inasmuch as an equal amount of general derangement may result from other injuries. The effect upon the constitution need not be of long duration; for, as soon as repair commences, there ought to be a *physiological condition* of the whole system.

The physical symptoms of fracture, to which the surgeon can in the main trust, as diagnostic features, are palpable to any beholder. The one which most frequently presents itself is a change in the natural form of the limb. Displacement of the fragments cannot exist without deformity, and the nature of the deformity will depend upon the form of displacement. Consequently, the surgeon will often be able to distinguish the form of displacement by the deformity which presents itself. The degree of deformity will depend upon the direction of the fracture, and the number and power of the muscles attached to the bone which is broken. Another trustworthy symptom is the *unnatural mobility at the seat of fracture.* The slightest contraction of the muscles, or a moving of the limb will be, in most cases, sufficient to cause motion at a point where, in a sound limb, it is impossible to have it. Change in the length of the limb, is commonly specified as a symptom; it is, however, but a change in the form of the limb. Being a common symptom, it requires special notice. The action of the muscles which are attached to the arms and legs mainly draw them toward the body; therefore, when one of the bones is broken, the lower fragment alone will be acted upon, thereby shortening the

limb. In oblique fracture the shortening is generally greater than in the transverse.

The next symptom to be noticed is *crepitus*. This, when present, is a valuable diagnostic symptom. It is a sound or sensation imparted to the hand of the surgeon, manipulating, and is caused by the broken ends, rubbing together. It cannot, however, always be detected; not so frequently, indeed, as is generally supposed. It will now and then happen, that the fractured ends cannot be brought together so as to produce the crepitus, and it may be here stated that the surgeon should never endeavor to make the crepitus. More especially, when the nature of the injury is palpable without the aid of this symptom. The violent and unnatural contraction of the muscles often preclude the possibility of approximating the broken ends; and the efforts of the surgeon to do so will only increase the difficulty. In fracture of the patella and olecranon, for instance, the fragments are so drawn apart by the muscles, that crepitus becomes impossible. Again, when there is impaction of the fragments, or an incomplete fracture, crepitus will be absent. Also, "crepitus may be distinct enough; but in such a direction as to mislead, on account of the relation of other bones to the one broken." (Hamilton.)

On the other hand, there is sometimes a sound like unto crepitus, which is produced by fibrin or synovial fluid, which has occupied the cellular tissue, and is now in a somewhat inspissated state. To create the crackling sound, pressure, or manipulation is sufficient. But this will never be heard until after a few days; whereas, true crepitus is more distinct, other things being equal, immediately after the fracture. Indeed, very often the crepitus will entirely cease after a few days, that is, when the broken ends become covered with reparative material.

Diagnosis.—The affections from which fractures have to be distinguished are *luxations, bent bones*, *sprains*, also from an *incomplete fracture*. In speaking of the several symptoms, it was deemed expedient to point out wherein each was important as a diagnostic mark, as well as in what way they might be deceptive.

In the majority of cases there will be no difficulty in discovering the existence of the fracture, when it has occurred at or about the middle of a long bone. But, when the fracture is near a joint, it may require some discrimination to detect it. The diagnosis of

fracture from dislocation will be more easily understood and remembered after the principles of *dislocation* have been discussed (to which please refer).

In the young, as well as from certain diseases, the bone may bend very near to the joint, and covered up by the muscles and other tissues, there may be presented an appearance closely resembling that of fracture. The history of the case, and a very little manipulation, will enable the surgeon to detect the one from the other. Sprains are sometimes mistaken for fracture, and *vice versa*. At first, before swelling has taken place, there can be no difficulty in the diagnosis; but very often the surgeon is only called in when the swelling and pain have become severe. Very often the swelling arising from the sprain gives the part the appearance of displacement of bone, such as attend fracture, or dislocation. It will be remembered that those tissues which are yielding, readily become swollen, and that it is contrariwise with those which are unyielding; hence the fact that the swelling about the joint is not uniform, and consequently, the appearance of displacement. Incomplete fracture may, at first, be mistaken, in consequence of the evident deformity, while at the same time there is no unnatural mobility. But careful manipulation, by the aid of other signs, will be sufficient to diagnose the case. A bone, thus half broken, can often be very quickly straightened. And the surgeon, before doing so, should point out its character to the patient and friends, otherwise, it may come to pass that they will doubt if a broken bone can so readily recover.

In proceeding to examine a broken limb, the surgeon ought to be quite possessed—free from trepidation, and in no hurry. He should constantly bear in mind the important principle, that no more manipulation is justifiable than is absolutely necessary to determine the nature of the injury, and to form correct views upon which to base the treatment. The old rude way of ruthlessly seizing the limb as if it were guilty of misdemeanor, was but a relic of barbarian practice, and is now, fortunately, almost obsolete. On this subject, I will quote from the pages of Hamilton. But while I do so, I must, in justice to myself, say, that two years before I had enjoyed the great satisfaction of reading his work, I taught the same principles, in almost similar language. He says, "I cannot dismiss this subject without calling attention to the

necessity of exercising care and gentleness, as well as skill, in the examination of broken limbs. Nothing, in my opinion, betrays a lack of judgment as well as of common humanity on the part of the surgeon, so much as a rude and reckless handling of a limb, already pricked and goaded into spasms by the sharp points of a broken bone. It is not enough to say that such rough manipulation is generally unnecessary; it is positively mischievous, provoking the muscles to more violent contractions, increasing the displacement which already exists, and not unfrequently producing a complete separation of impacted, denticulated, transverse, or partial fractures, which can never afterwards be wholly remedied, augmenting the pain and inflammation, and not unfrequently, I have no doubt, determining the occurrence of suppuration, gangrene, and death."

The patient should be placed in the most comfortable position, and divested of all unnecessary clothing, which should be *cut off* the injured limb, although the friends may seemingly think the garment of greater value than the limb. Then, sitting down quietly by your patient, endeavor to inspire confidence, and relieve his mind of unnecessary apprehension. Place your finger upon the bone, at some distance from the site of injury, and then trace along its course; and, when the bone is superficial, the diagnosis will be easily established. If there be much pain and twitching of the muscles, they may be palliated by the application of warm water, or a little sweet oil. When the pain is intense, or the diagnosis difficult, making a protracted and strict examination necessary, chloroform ought to be administered. It would seem hardly necessary to say that the diagnosis should be made immediately after the injury; yet the young practitioner will sometimes feel disposed to postpone the examination until he has consulted some authority. Now, while the surgeon ought to fortify himself by counsel, he should not defer that manipulation by which he is to decide the character of the fracture. The swelling which will so soon follow, will render the examination uncertain, perhaps fruitless. The existence of unnatural mobility, and the direction of the fracture, can both be learned by lateral pressure, and gentle rotation of the limb. And in this way crepitus will also often be elicited.

In those cases where the surgeon cannot satisfy himself as to

the exact nature of the fracture, and he will often have reason to doubt, he should express himself in guarded language. And when the doubtful point is one involving the integrity of the limb, or the life of the patient, he should suggest the propriety of a consultation.

Prognosis.—In offering an opinion as to the length of time which will elapse before the bone will be restored, many things must be duly considered. First, the size of the bone must be taken into account; the larger the bone, the longer will be the time necessary for union to be effected. The seat of fracture will qualify the prognosis. Speaking generally, the opinion will be more favorable when the place of fracture is removed from the joint. Again, if the fracture is so situated, that a good deal of motion may be expected to take place, union will not so expeditiously take place. The number of muscles, and their power to contract, by which the fragments may be displaced will, to a greater or less extent, interfere with the healing. When the fracture is oblique, displacement is favored, and union retarded. The extent of injury to the soft parts will also weigh with the surgeon; for, when the injury has been severe, there will be, necessarily, some inflammation, which always, whatever its cause, delays the process of union, and should pus form, there will be a serious complication, so that the resources of nature will be more seriously taxed. Still, again, when the force has been direct, and also of great violence, by which the bone has been crushed, or comminuted, perhaps denuded of periosteum, or in some other way deprived of its ordinary supply of blood, as when the wheel of a wagon, heavily laden, passes over the tibia, the restoration will be tardy, perhaps uncertain; the leg may be in danger, perhaps even the life, or some local disease, as caries, may follow. Fracture near a joint, accompanied with luxation, will prove tedious and uncertain as to cure. The wound of a large artery, or an injury to a large nerve, will also interfere with the recovery. Finally, the age and health of the patient must be good, in order to a certain and perfect union of bone.

CHAPTER XXXVII.

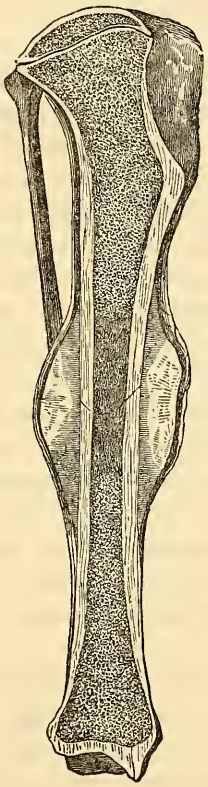
Healing Process of Bone: Pathology—Treatment. Three Indications: 1. Restore Bone; 2. Retain; 3. Prevent Inflammation. Appliances: Bandages—Compresses—Splints.

Healing Process of Bone.—In speaking of the "healing process," very general principles have been given, and those principles apply to the work of healing in bone as well as to other tissues. Those principles were very general, because they are so very simple, applying equally to all tissues of the body. Surgeons a few years ago would have hesitated to receive the statement that *immediate union of bone* were possible; indeed, it is but yesterday that it was admitted to be possible in the softer tissues. To Mr. Paget are we particularly indebted for the elucidation of this subject.

In *immediate union*, the broken ends unite "in the same manner that the soft tissues sometimes unite, by the direct reunion of the broken surfaces, and without the interposition of any reparative material. This happens not unfrequently in the spongy bones, and in the extremities or spongy portions of the long bones, especially when one portion of bone is driven into and becomes impacted, as in certain fractures of the neck of the humerus or of the femur." (Hamilton.)

Mediate union is the most frequent form; and it is most important to understand that the bond of union may be very limited in thickness, or it may be very great. As in the wound of soft parts, so in the bone: a scarcely appreciable portion of plasma may bathe the broken ends, or they may be thickly covered. If the fracture is simple, and the fragments be retained immovably in apposition, then there will be no irritation to lead to the effusion of fibrin. Instead of this adventitious matter, there will be direct union by osseous deposit. The greatness of this principle will become apparent when we come to consider the treatment of fracture. The old doctrine of provisional and subsequent definitive callus being necessary steps in the process of cure, is now tottering to its fall;

neither provisional nor definitive callus is necessary. The former is never seen in the cure of a simple fracture, if the surgeon can but succeed in keeping the bones together and strictly at rest. Callus is only thrown out within and around the ends of the fragments, when the surgeon fails to supply a retentive apparatus. The definitive callus will be very little if the pieces are properly and securely adjusted. When the sharp broken ends are allowed to move, they will cause pain, irritation, congestion, and the elaboration of fibrin, which nature intends, n her wise way, to convert into a hard substance to hold the ends together, and a very little of this may prove sufficient. There may, indeed, be only what was formerly designated definitive callus—simply a bond of union between the broken ends. When the quantity is greater it will then also occupy the medullary canal, constituting the "interior callus," or the plug. In connection with this, there will likely be a quantity around the ends of the bones, thus "ensheathing" it. This latter may exist without the definitive being detected; in such cases, probably, the bond of union was limited, and afterwards speedily absorbed. It will therefore be understood, that continued moving of the bone when it ought to be in a state of repose, will lead to the deposit of a large, perhaps unlimited quantity of fibrin; and it will be found, that in those cases where there is exuberant callus, there had been continued irritation, from unceasing motion of the bone. And when there is lapping of bone there will be still more irritation, yet no more than is requisite to call forth that amount of reparative material which is required to fix the fractured ends.



The whole pathology, then, is summed up in this: that in the union of broken bones, no more provisional matter is formed than is necessary to constitute a bond of union; that in a simple frac-

ture but little or no provisional material is supplied, if the fragments be retained in a state of repose, as in that case nature will proceed *directly to unite the divided osseous fibres by osseous deposit; and that when there is provisional matter, it results from occasional or continued motion of the fragments.* The conclusion to be drawn from the foregoing facts is, that if the surgeon fails to supply splints, nature endeavors to supply them; and the provisional callus thus called into existence has been appropriately termed nature's splints.

In those cases of fracture where there is some local complication, inflammation is likely to take place, and consequently healing is impossible until the inflammation subsides. Following, there will be no regular course of healing; yet there will be a wise arrangement of nature by which a process of repair will take place, strikingly analogous to *healing* by granulation in the soft parts. If the patient be healthy, and the part placed in a proper position, healing will with rapidity follow, unattended with much discharge.

It is convenient to divide the organization of provisional callus into stages: first, the effusion of the lymph; second, its coagulation; third, its period of life; fourth, substitution of bony matter for the provisional material, and removal of all the adventitious substance by absorption.

The steps by which organization is accomplished are the same as those we have traced before. (*Vide* Healing Process.) Through the agency of new vessels, the organized fibrin is gradually superseded by osseous tissue. During the first stage, while the lymph is being effused, there will be, even in a simple fracture, some swelling; and during the second stage, circumscribed swelling will generally exist. Thereafter, the appearance of the limb will in many cases be natural, except when the provisional callus is extensive. At first this is flexible; but as the osseous matter increases, the substance becomes more firm, and finally unyielding. During this process of changing, it will at first become cartilaginous in consistence, and finally osseous. As long as this is yielding, the limb should be retained at rest; and should the pieces have become united at an angle, the bone may, by proper pressure, be brought into its natural shape.

The time required for the work to be completed will depend

upon the size of the bone, the absence of inflammatory action, and the state of quietude in the broken bones; also the health, age, and general condition of the patient and of the tissues in the part.

In a healthy subject, after a fracture has united, the bone is quite as strong as ever; and often, when the limb is subsequently exposed to violence, fracture will more quickly take place elsewhere.

Treatment of Fracture.—Associated with the various remedial measures, is the course of procedure which ought to be observed by the surgeon in superintending the removal of the patient when he is unable to walk. Fractures more generally occur to persons when away from home; and before the first step can be taken in the treatment, the patient requires to be removed to the bed upon which he is to lie. The surgeon, if called immediately, will have the patient placed upon a stretcher—an old door is very good, made comfortable by the coats of those present who may be willing to administer to his comfort. The surgeon will himself have the immediate care of the broken limb, not only to secure the greatest ease to the patient, but as well to prevent displacement, from which the case would be complicated. Having reached the house, he should see that the chamber and bed are fully prepared for the patient's reception, and, in carrying him into the bedroom, have it done in such a way as will allow transferring of the patient to the bed with the least pain and disturbance of the limb.

The patient duly settled in bed, place the broken limb in a *comfortable position*—and very much is embraced in the word *comfortable*, for if a broken limb can be so placed, the work of repair will forthwith commence. That is to say, it does not necessarily follow that because a certain kind of fracture exists, a particular kind of apparatus must be in use before repair can commence. The only thing requisite is to make the limb comfortable, and, of course, to keep it so. *And as a general thing, when the limb is free from pain, the position of the broken bone will not be far from the natural one.*

The three principal indications in the treatment of fracture are, 1st, to restore the fragments to their natural position, by the doing of which the limb will be brought into its natural shape; 2d, to

retain the bones in that position; 3d, to prevent and control inflammatory action.

"Setting" the bone is an operation which the patient very much dreads, and for which the surgeon is allowed, more particularly, to charge his fee. But if the surgeon will go carefully to work (*vide* diagnosis), in the majority of cases the pain will not be so very great; and the surgeon well knows that the bones may be placed a dozen times in proper relationship, and be as often displaced by muscular action, or by the weight of the limb. *The real difficulty is not in setting the bone, but in keeping it set.*

To carry out the first indication, no definite rules can be given. The steps to be taken will depend upon the bone fractured and the nature of the fracture. Over and above what may be done in the examination, to establish the diagnosis, nothing need be attempted until the apparatus which the case demands is fully prepared. Indeed, the surgeon should avoid disturbing the patient till he is quite ready to apply the splints. The nature of the displacement, if any exist, will be duly considered; and as the first and principal thing is to replace the bone, the cause of the displacement must, if possible, be removed. Muscular action is the most frequent cause of displacement, and to overcome it, the surgeon has been recommended to employ extension and counter-extension. This is a practice which cannot be too earnestly condemned. Now and then force may be necessary, but they are exceptional cases. When the displacement has resulted from external force, or from the falling of the limb or body, a broken end may have been driven into the soft tissues, and there remain. In such cases extension will be necessary to extract it. When the ends lap from muscular contraction, the parts may undoubtedly be restored by extension of the limb; but, unless it be continued, the bones will relapse into their former state. It will thus be seen that only when the end of a piece is driven into the soft tissues, should extension be resorted to. Not only is this practice unnecessary, but it is very objectionable. Manipulation of any kind, beyond what is actually necessary, is an evil; and extension is the worst form of manipulation. The best proof of this is, that it causes pain to the patient; and it cannot be wondered at. The parts around the fracture are irritated, often lacerated. The periosteum at the part is intensely congested, and in a simple frac-

ture it may be only partially severed. Now, drawing upon the bone will increase the irritation, and intensify the congestion; and when the periosteum be not altogether separated, it will quite accomplish it; and still more, the muscles will sympathize with the part irritated, and resist the efforts made to overcome their action, for they are, to a great extent, guardians of the bone, and contract involuntarily when the bone is in pain, and then will cease to contract when the parts are placed in an easy position. We now come to the essential point: how are we to overcome that muscular action which produces and keeps up displacement of bone? Now, instead of attempting to do this by extension and counter-extension, efforts should be made to so flex the limb or body as that the engaged muscles may be relaxed. *When all of the muscles are in a state of quietude, the broken pieces will naturally take their ordinary position in relation to each other.* And, if no cause of displacement be in operation, the first indication in the treatment of fracture is thus fully met. With one notable exception, that is fracture of the femur, almost every fracture to which the bones of the body are liable, may be treated on this principle. Keeping this in view, much can be done by soothing the system generally, by quieting apprehension, and by the local application of anodynes.

When extension is necessary, it should be made with gentleness, yet with sufficient firmness; but avoid sudden or violent force. While extension is being made by an assistant, the surgeon will, by direct manipulation, endeavor to mould the limb into its proper form. Sometimes a fragment is drawn out of place by the action of a single muscle, or the weight of the limb; it is in such cases more than useless to attempt to force it into place by pressure; the only way is to support the pieces in that position which will allow them to come together.

The *second indication* is to retain the fragments in their natural position, and so surely that all kinds of motion will be prevented. To do this, mechanical means are generally necessary. In persons of mature age, who will voluntarily keep a limb in a required position, by night and by day, but slight means will be necessary to meet the requirements; yet such procedure is not unattended with risk.

Rest of the body, proper position of the body and of the injured

limb, bandages, compresses, and splints or other apparatus, are the means by which the bones may be kept together. In order to secure rest to the body, the bed should be so made as to meet the wants of the patient, and as to suit the position in which the leg will require to be placed. As to position, *a natural one* is, generally speaking, *the most comfortable one*, and it will favor relaxation of the muscles, which is so desirable.

With respect to appliances, I will give what I conceive to be a valuable rule, and which I have often urged in the class-room, namely, *to use as few splints and bandages as will secure the required object. If a bandage will do the work, then apply no splint; if one splint will answer, do not use two.* The various appliances should be of the lightest material which will meet the wants of the case. Keeping the above principle in view, it will be understood that no bandage should be applied directly to the limb, before the splint or splints are adjusted. The bandage is used principally to fasten the splint, but it will also, by its uniform pressure, prevent to some extent spasmodic action of the muscles, and give general support to the limb. But the latter advantage is quite as well secured by the application of the bandage over the splints. To protect the skin from irritation by the splint, padding of cotton or wool can be used.

When the splints are prepared, the limb will be bandaged from the extremity upward, until the point is reached to which the lower end of the splint will reach. Then the splint or splints having been placed in their proper position, the bandage will be continued over them, and up the limb so as to securely fix the whole.

A bandage applied under the splints is not only useless, but it is likely to prove injurious. The surgeon has to inspect the seat of fracture almost daily, and the existence of two bandages will materially obstruct the necessary view; to remove one would be to expose the bone to redisplacement. A more urgent objection is the fact that in all fractures there will be some swelling after the application of the bandage, especially if the bandage is at all tightly applied, and pain will result, which may lead to inflammation. To counteract this evil, it should be in the power of the surgeon to loosen the bandage at any time: this can only be done when it is not immediately applied to the skin; at least, without disturbing the splints. I have generally secured the necessary

relief in this respect, by partially dividing the bandage, here and there, and afterwards, when the swelling had subsided, united them again with a needle and thread. Moreover, when a soft pad is placed under the splints, there will be, to some extent, an accommodation of the splint to the swelling limb.

There are two kinds of bandages, the roller and the many-tailed bandage, or the bandage of Scultetus. The roller or continuous bandage is preferable for general use, as it can be more evenly applied, and its position is less likely to change. It is commonly used in simple fractures. When the fracture is compound, or there is a wound, or any other serious local complication, the other form of bandage will be found more advantageous, because of the facility it affords to examine at any time the injured part. The increased advantage of the Scultetus bandage is, that when there is a discharge from the wound, one or more pieces can be removed, and clean ones substituted. This may be done even without moving the broken limb, by pinning fast the clean strip to the one about to be removed, so that when the latter is withdrawn, the former will follow it into position under the limb.

In the fracture of smaller bones, I have used adhesive strips to hold the splints, and have found them to be an excellent substitute for the bandage. A few are sufficient, and they leave the limb to a great extent uncovered.

Compresses are sometimes called into use; perhaps too frequently. There cannot be a more mischievous procedure than to fix a compress upon the broken end of a bone which is displaced by muscular action, as in fracture of the femur when the psoas and iliacus act upon the lower end of the upper fragment. As elsewhere explained, the lower fragment ought, if practicable, to be brought upward, so as to be in relationship with the upper one. Again, a compress should never be employed to force into place an unreduced bone, as it may lead to serious complication. The only use to which it can be properly put is to prevent any slight disturbance to which the limb may be exposed. The pressure should never be so great as to interfere with the capillary circulation; otherwise, sloughing or gangrene may follow, lamentable cases of which have come under my notice. The compress may be of cotton folded, or of wool.

Splints.—Let it be remembered, the splint should always be as

light in weight and limited in thickness as is consistent with the object to be secured.

It may be made of a variety of materials, such as metals of various kinds, reeds, unbroken straw in bundles, wood, leather, pasteboard, or millboard, gutta-percha, cloth stiffened with gum, cotton with starch, plaster of Paris, &c. As a general thing, *the splint should be especially prepared for the case.* So varied are the fractures in the same bone, and in the same locality, and, at the same time, so unlike are the limbs of any two persons, that the surgeon will find it impossible to adapt a set of splints to every patient. I have had the honor of enunciating these views in the class-room each year of my teaching; but so admirably are they advocated by Hamilton, that I cannot do better than give his words on the subject. He says: "But I wish at once, and for all, to disclaim any intention of giving even a qualified approval of any of those carved, polished, and generally patented wooden splints, which are manufactured and sold by clever mechanics, and which one may see suspended in almost every doctor's office, whether in the city or in the country. Constructed with grooves and ridges, and variously inclined planes, for the avowed purpose of meeting a multitude of indications, such as to protect a condyle, to press between parallel bones, to follow the subsidence of a muscular swelling, &c., they never meet exactly a single one of these indications, whilst they seldom fail to defeat some other indication of equal importance. They deceive especially the inexperienced surgeon into the belief that he has in the splint itself, a provision for all these wants, and consequently lead him to neglect those useful precautions which he would otherwise have adopted." I taught these views years before I saw this excellent work; but so important are they, that I desire to give them the weight of this high authority.

A shingle or a bit of cedar, or a cigar-box, can at any time be quickly made into a splint so shaped as to fit the limb, and covered perhaps with cotton-wool and a bandage. I have often made an excellent splint of sole-leather, or thick upper leather. A very useful splint is sometimes made by veneering a calfskin or a sheepskin with thin strips of light wood. "Felt, made of wool, saturated with gum shell-lac, and pressed into sheets, makes an excellent moulding tablet for splints." "A much cheaper material is

an old piece of broadcloth, or any similar closely woven texture, by saturating it thoroughly with gum shell-lac, the gum being dissolved in alcohol in the proportions of one pound of the former to two quarts of the latter. Thus prepared, it is to be spread upon both surfaces of the cloth with a common paint-brush; a second and third coat must be spread upon one of these surfaces after they are dry." (Hamilton.)

Gutta-percha is very good for splints, but less expensive material will answer equally well.

"In 1834, Luctin, of Brussels, introduced the use of starch as a means of hardening the bandages, his method of using which is essentially as follows: A dry roller is first applied to the skin, and then smeared with starch, all of the bony prominences and irregularities of the limb are filled up or covered with cotton batting, charpie, down, &c.; strips of pasteboard, or of binders' board, moistened and covered also with starch, are now laid alongside the limb, over which again are turned in succession one, two, or three layers of the starched roller; the number of rollers and the thickness of the pasteboard being proportioned to the size of the limb, or to the required strength of the splint. The whole is completed by starching the outside of the last bandage.

"This dressing will generally become dry within from thirty to forty hours, which process may be expedited by exposing its sides as much as possible to the air, or by the application of artificial heat with bags of dry sand, or with hot bricks.

"As soon as the bandages are dry, they are to be cut along the front to a sufficient extent to permit of an examination of the limb, and then closed with an additional roller.

"On the third or fourth day, or as soon as the subsidence of the swelling may render it necessary, the bandages should be cut open through their whole extent, the edges pared off and brought together again snugly with an additional roller.

"For myself, I am quite as much in the habit of using wheat flour paste as either starch or dextrine, and if properly made it dries about as quickly as the starch, and is equally firm." (Hamilton.)

In accordance with the principle that no unnecessary application should be employed, this form of bandage, called the immovable apparatus, ought not to be used except when there is, from

some cause, delayed union of bone. In no case should the bandage be prepared before such swelling as may be expected, has reached its maximum. The practice recommended by some, of applying the starch bandage immediately after the injury is most questionable.

The third indication in the treatment of fracture, is to prevent inflammation; and if it exist, to endeavor to control it, and prevent suppuration.

In a simple fracture no inflammation should follow, nor will there, if the first two indications be properly carried out. When, however, there is a complication, such as bruising, or laceration of the tissues within, a degree of inflammation may be expected to follow. The surgeon cannot be held responsible for existing complications at first, but he may be for those which subsequently arise. Sometimes, even in a simple fracture, there will be a great deal of pain, due probably to an injured nerve, or perhaps to a spicula of bone, or it may be extreme nervousness. This may be, to some extent, relieved by the application of anodynes, or by their internal exhibition. In a simple fracture, however, when there is no pain, no applications whatever should be employed. Washing the part will prove beneficial, but nothing else.

At any time after splints and bandages have been adjusted, it matters not with how much care, should pain and swelling commence, indicating danger of inflammation, the bandages must be loosened, and if that do not suffice, they and the splints must be removed until ease is obtained. *Healing cannot commence so long as there is pain and inflammation*, and therefore when they arise, the surgeon's attention will be exclusively directed to their suppression, treatment being based on general principles. Should an abscess form, it will have to be duly opened.

The surgeon ought to inspect the limb daily for several days, to see that it is perfectly comfortable. Attention to a very little thing in time may prevent serious mischief. Phlyctæna may form, when they ought to be emptied, at the same time preserving the cuticle. During convalescence the surgeon must give due caution against secondary fracture, else, if it occur, he may be blamed. When the fracture is situated near a joint care must be taken lest there be partial anchylosis for a while.

CHAPTER XXXVIII.

Treatment of Compound Fracture: Irregular Callus—Causes—Treatment—Exuberant Callus—False Joint—Causes—Treatment—Diastasis.

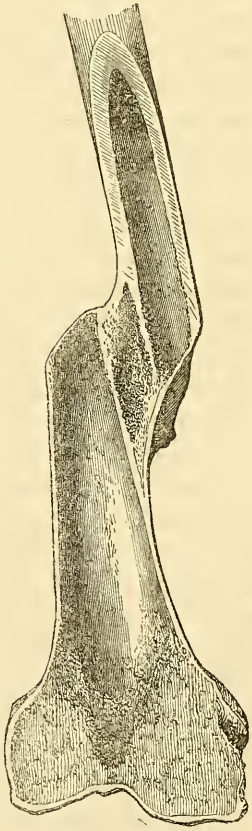
Treatment of Compound Fracture.—If the peculiar wound partake of the character of the incised, it may soon heal, and thereby the compound be converted into a simple fracture. When, however, the soft parts are so injured that healing will have to take place by granulation, then healing of bone and of the soft tissues must progress together. At first attention will be directed to those measures which will prevent or lessen inflammation. (*Vide* Treatment of Wounds.) The principal indication at first, so far as the fracture is concerned, is to place the limb in a comfortable position, supported by an apparatus so arranged that due attention can be given to the wound, to cleanliness, &c. When healing is about to begin, then the ends of the bone should be so moulded that the proper form and length of the limb will be secured. Gradual and continued extension of the limb will often accomplish this. Or the application of a starch bandage, with an opening in it at the seat of the wound, will often answer those ends; and perhaps allow the patient to move about. This, however, is more likely to be practicable when the union of the bone is far advanced.

In a recent compound fracture the question may present itself: can the limb be saved? No fixed rule can be given; but, in accordance with the principles of modern conservative surgery, if there be but a slight chance for recovery the patient should have the benefit of that chance. The powers of nature are often very great. If the main vessels and nerves be uninjured, the surgeon ought not to despair, unless there be some other cause of depression. And, if the age, habits, and other circumstances be favorable, no matter how much bruising, or tearing, or comminution of bone, an effort should be made to save. Of course the dangers are not a few. The shock is often great. There may have been loss of blood, and the discharge may be exhausting. Tetanus may supervene, and therefore the surgeon will not, without profound

deliberation, or a consultation, decide as to which is the most judicious course.

But when the limb is literally crushed, as by a railway carriage; or a joint is seriously involved; or the vessels or nerves destroyed, amputation will be the only procedure which can be adopted.

The time at which the operation should be performed will depend upon the state of the patient. Convinced that the limb must be removed, the earlier it is done the better for the patient, but if the shock has been great, it will be necessary to wait until he has rallied. At any time during the course of treatment, if the injured limb seems to be a source of irritation and exhaustion beyond what the system can endure, amputation must at once be resorted to.



Irregular Callus or Deformity.—From what has been said with regard to the healing process of bone, it will be understood that the quantity of "ensheathing" "provisional callus" will depend upon the degree of pain, and the amount of motion at the seat of fracture. When there is continued displacement, and unnatural contraction of muscles, the reparative material is extensively thrown out, and thus efforts are seemingly made to grasp the moving bones and hold them, so as to prevent motion. But this is not effected until the fragments are displaced by the constant motion. In this way the callus often becomes irregular, while at the same time and from the same cause, there is perceptible deformity.

Causes.—Certain kinds of fracture are disposed to this unfortunate evil, that is those which are with great difficulty retained perfectly still. Neglect or unskilful treatment is too often the cause. Not unfrequently wilfulness of the patient is the sole cause; that is, by persistently disobeying the surgeon's directions.

Treatment.—The callus remains pliable for a time, sometimes a protracted period; and while it is yielding, the deformity may be remedied by *extension* of the limb, and by judicious *pressure.* Dupuytren records several cases where a cure was thus effected. A *seton* passed through the part to produce suppuration, may so soften the new material as to allow replacement by extension. Another method, sometimes practised, is to forcibly break the crooked bone—to *rupture* the callus. But this procedure must not be rashly adopted. If the callus is abundant and has become very firm, which may be the case, the force requisite to break it will be very great, and more especially, as there will be danger of breaking the bone elsewhere. The following points must be fully estimated: the length of time since the fracture, the size of the bone, the situation in the bone, the age of the patient, &c., and, also, the degree of deformity, to what extent the function of the limb is impaired, his situation in life, and his own desires. Having determined to rupture the callus, let chloroform be given to the patient; then seize the bone, and so apply force, as to concentrate it at the desired point. I have seen an apparatus used by Dr. Buck, of New York, the nature of which I now forget. After the bone is rebroken, the same treatment will be pursued as in an original fracture. It is recommended, when the callus is so firm that it may not be ruptured, to *resect* it by the aid of the saw. This operation may be followed by some shortening; but even that may be preferable to the deformity.

Exuberant Callus is sometimes met with when the limb is even quite straight. In such cases there must be some cause of irritation, leading to the unnecessary elaboration of reparative material. It may be an irritated nerve, or a spicula of bone, which, being frequently moved, keeps up the pain. Whatever the cause, it must, if possible, be removed. The superfluous callus may be absorbed, or itself become a source of continued irritation, rendering its removal absolutely necessary.

False Joint—Pseudarthrosis.—Nothing more unfortunate can befall the surgeon, especially a young one, than to have a case of fracture which, after the usual course of treatment, remains ununited. The limb has been kept in the proper apparatus, sufficiently at rest, and the length of time usually prescribed. Nothing untoward has attended the treatment, and the surgeon has, with

some confidence, declared that the limb, upon removing the splints, will be found altogether well—the union perfect. But to his great chagrin, it is found to be as when it was placed in the splints—that there is *non-union*. Such will now and then be the experience of the most competent and careful practitioner. But, alas, non-union is too often due to carelessness, or want of skill on the part of the surgeon. Or, the patient may be to blame, having refused to submit to the necessary restraint, and the consequence has been continued motion in the part, which precluded the possibility of ossific union. The false joint may be more or less perfect. Although there is no bony union, there may be a ligamentous. One end of the bones may be rounded, while the other is somewhat cupped. This is done by the absorbents, and is the necessary provision for a new joint.

Causes.—The following constitutional causes are given: the syphilitic and the scrofulous diseases, ill health, pregnancy, low fevers, cancerous disease, paralysis, scurvy, fragilitas ossium, deficient supply of arterial blood, old age. The local causes are frequent motion at the seat of fracture, non-approximation of the fractured ends, disease of the broken bone, soft tissue intervening between the fragments, perhaps a muscle, tight bandaging, long continued application of cold water, presence of an ulcer, a loose piece of bone, separation of the periosteum, too early use of the limb. Two or more of these causes may coexist.

Treatment.—The surgeon should always, in the treatment of fracture, bear in mind the various causes which may lead to false joint, and at all times watch for them; and, when existing, endeavor to remove them, or prevent their evil effect. Moreover, if apprehensive of non-union, he ought by all means to apprise the patient of the possibility of the bones remaining ununited. Otherwise, he may be held accountable, and may even be chargeable with malpractice.

When the evil actually exists, even the removal of the cause may be followed by union of the bone. In every case, when the surgeon finds the bone ununited, he should reapply the splints, and attack the cause. If there has been too much motion, endeavor to prevent it. This may be accomplished by a starch bandage, continued for several months. If the non-union has existed for some time, and a false joint has really been formed, union is not

likely to take place, until the ligamentous substance therein has been destroyed. This can sometimes be done by rubbing the ends together for a few minutes, before placing the limb in splints. Caustic to the skin over the part has been recommended, also the introduction of needles heated, between the ends, and also a seton may be employed. Anything to produce disorganization of the new adventitious matter forming the false joint. Resection may be resorted to. Care must be taken to remove the whole of the abnormal substance so as to have pure bone come together. Thereafter, the limb being placed in the proper splint, union may take place. Sometimes the fragments may be fastened together by ivory pegs. Sometimes the continued motion, which prevents union, is due to an unruly muscle. This constantly draws the fractured ends apart. In such cases it may be expedient to divide the tendon by subcutaneous section. When a muscle or other soft tissue is fixed between the pieces, it may likewise be necessary to perform resection, not so much to remove the ends of the fragments as the interposed substance.

Diastasis or Separation of Epiphysis.—This may happen in children, before the bony structure is complete or firm. The child, exposed to violence, instead of a fracture, there is separation of the epiphysis from the shaft. It may also result from muscular action. The diagnosis of this affection is not always easy, that is, from ordinary fracture; but as the treatment is the same as in fracture, it is not a matter of essential importance.

CHAPTER XXXIX.

Surgical Affections of Joints—Joints most liable—Inflammation—Causes—Synovitis—Symptoms—Prognosis—Pathology—Inflammation of outer Tissues—White Swelling—Morbus Coxarius—Results.

Surgical Affections of the Joints.—The anatomy and physiology of any structure is essential to a correct understanding of those diseases to which it is subject. It is pre-eminently so with regard to the joints. The bony framework of the body

is composed of pieces, and these pieces are united in such a way as to allow a variety of motion between them. There is articulation and motion. Accompanying this there must be strength, and therefore they are bound together by strong ligaments. To facilitate motion between the ends of the bones, there must be smooth surfaces; this is secured by smooth synovial membrane. Then, the ends have to be firm, and at the same time yielding, hence the compact and elastic cartilage covering the ends of the bones. The arrangement to meet the above stated requirements is most admirable. Entering into the formation of the joint is the bone covering; this is the dense cartilage, which in turn is covered by the synovial membrane. This membrane is a closed sac, like serous membranes; yet it is unlike them, and the pathological changes incident to it are materially different. This membrane secretes the fluid to lubricate the joint. Binding together the bones are strong ligaments; these are placed outside the joint, and cover it, being lined by the membrane. Outside the ligamentous structure, and in close connection, are generally tendons of muscles, and over all is the integument. Now all these structures, so different in character, are, nevertheless, in very close relationship. They are fed by the same vessels, and supplied by the same nerves. Consequently, when disease invades one tissue, it is very apt to extend, by contiguity, as well as from nervous sympathy, to other tissues. Again, every tissue of the body may be said to be predisposed to certain kinds of affections, and the tissues entering into the joint being numerous and various, the joint as a whole is exposed to a large number of maladies.

The joints of the body most liable to disease, are those which are superficial and exposed to injury, and which have at the same time varied motion. Therefore, the knee is more frequently the seat of disease.

Inflammation of Joints.—It may be idiopathic, or it may be symptomatic. Its course may be acute, subacute, or chronic; so quick in its action as to lead to speedy destruction of tissue, or so slow that it can scarcely be denominated inflammation. It may begin in the hard structures, or in the softer. The most prominent cause of the disease, will have to do in selecting the particular tissue first involved.

Causes are *constitutional* and *local.* Of the first are rheuma-

tism, gout, gonorrhœa, leucorrhœa, suppression of ordinary discharge—by metastasis, mercurial poison, catheterism, general debility. The *local* causes are blows, strains, wounds, mechanical injuries of all kinds, foreign bodies in the joints.

Synovitis in its various forms is the most frequent kind of joint disease; consequently, in speaking of inflammation of the joint generally, I cannot do better than to follow the course of inflammation as presented in this particular tissue.

Inflammation of the synovial membrane is a disease of somewhat frequent occurrence in the adult. It may be primary or secondary.

Symptoms.—*Pain* is very constant, and generally very great, and will be increased on motion of the joint. The intensity of the pain will, to some extent, indicate the acuteness of the disease. *Swelling* takes place early, and may be due to effusion into the joint, or into the circumjacent tissue, or perhaps in both. *Redness* is not present at first, but is in the later stages of the disease. *Heat* is usually present. All of these symptoms are better marked at night, and cause restlessness and constitutional disturbance. But the most characteristic symptom of this disease is the fixed position in which the joint is placed. The reason of this is obvious. The slightest motion in the joint intensifies the pain; the inflamed synovial membrane is at such times exposed to pressure between the ends of the hard bones. This acute pain begets sympathy in the muscles related to the part, and they at once begin to contract—contract firmly, the whole of them, around the joint, flexors, and extensors. The consequence is, the joint is fixed, and (what is important to note) this rigid state of the muscles tends to increase, at least to continue, the pressure upon the sensitive membrane. But some of the muscles around every joint are more powerful than others, and their rigidity is more incessant. In consequence of this, the limb will become gradually flexed—a phenomenon often witnessed in inflammation of the knee-joint. This takes place so slowly, that it may not be discernible from day to day, but only when several days of interval are considered. On this subject, I am much indebted to the teachings of Hilton.

Diagnosis.—It is not difficult to diagnose inflammation of the joint, but it may be to distinguish *synovitis* from inflammation of other tissues in the joint. This, however, is not important, so far

as the treatment is concerned. To detect effusion into the joint which results from synovitis, the surgeon will be assisted by considering the form which the joint presents. Remembering the situation of those points where the membrane approaches to the surface of the limb, and which are not covered by any unyielding tissue, it will be expected there to find unusual prominence, or fulness, from the fluid pressing outward. The presence of fluid in the joint would not alone prove the existence of the inflammation, inasmuch as *dropsy of the joint* may result from other causes. It is, however, a valuable diagnostic mark when other symptoms of recent inflammation are present. The sensation of fluctuation about the joint is often deceptive. More than one accomplished surgeon has made an incision over a joint, expecting to find fluid, but who found none. The feeling of fluctuation is due to effusion of serum into the cellular or adipose tissue external to the cavity of the joint.

Prognosis.—This should always be guarded. Sometimes, under the most careful treatment, in spite of everything, the inflammatory disease gradually merges into some species of degeneration, or ulcerative destruction of one or more of the tissues, and results in the loss of the joint. The opinion will be more unfavorable when there is a predisposing constitutional cause.

Pathology.—In connection with synovitis, it will be advisable to discuss the *various products of the disease.* Various forms of synovitis have been described by Brodie and others. Several divisions of inflammation and degeneration have been given by writers. This multiplicity, perhaps, tends to confuse the student, without conferring any commensurate advantage. My object always is to simplify as much as possible, while I make plain that which is essential.

Synovitis proper is attended and followed by the ordinary products of inflammation. The joint is intended for motion; and although the synovial membrane lining it so closely resembles the serous membrane anatomically and physiologically, there is this important difference pathologically: when fibrin is poured out upon its surface, as a result of inflammation, instead of its displaying a tendency to organize, as it does upon a serous membrane, it shows a disposition to degenerate into pus. The lymph is more corpuscular than fibrinous. At the same time, the occasional mo-

tion of the joint prevents the existence of the condition necessary to allow adhesion. Here is manifested an admirable provision of nature. The joint is for motion, and nature takes care that, even in disease, this sole function shall not be jeopardized. The formation of pus is undoubtedly a serious result; yet it would seem that the requirements of man are such, that it were better to have pus formed in the joint, *which may be discharged without necessarily destroying the joint*, than that the joint should be impaired or destroyed by adhesive inflammation.

It is, however, only when the inflammation is acute that the resulting fibrin is likely to degenerate into pus. When this action is subacute or chronic, other results follow, no less serious and destructive. The congestion, more passive than active, leads to effusion of liquor sanguinis (with a large proportion of serum) into the sac, or into the substance of the membrane and the adjacent tissue. The inflammation may at first have been acute, during which lymph had been effused upon the free surface of the membrane; subsequently, the inflammation becoming less active, liquor sanguinis is poured out, with a larger quantity of serum, and with lymph possessed of a low standard of vitality. This process of asthenic disease, with deposition of imperfect fibrin, may continue for an indefinite time, and the fibrin all the time undergoing a species of degeneration, and terminating by affecting the vitality of the tissue in which it is deposited. Thus, the membrane may be gradually thickened and softened to a very great extent. The lymph does not always at once degenerate, either into pus or in any other way. It sometimes will remain for a time in a semi-organized state, and thereafter begin to decline in vitality, and finally to perish. Sometimes it will be seen floating in flakes in the cavity of the joint. On the other hand, occasionally, the adventitious substance will undergo a form of organization upon the membrane, something like granulations. The result will be, numerous villous processes with fringed borders. (System of Surgery.)

When the synovial membrane becomes thickened and soft, in the manner above described, it is commonly known by the term of "white swelling." It is not only soft, but it is often pulpy and gelatinous. The thickening is often very great, sometimes even to a quarter or half an inch, or even an inch. The fluid within the joint, and the membrane itself, presents sometimes one color,

sometimes another, there being quite a variety: sometimes a light brown, or a reddish hue.

We have seen that synovitis may be acute, or it may be very chronic, but that no line of separation can be drawn between; moreover, that the acute may become chronic; and finally, that it may degenerate into a disease which cannot be said to possess any feature of inflammation. But in all these varieties, the adjacent tissues are equally exposed to danger. The cartilage, so closely united to the synovial membrane, will soon suffer, and begin to disappear by a process of ulceration. The bone, being in immediate relationship with the cartilage, cannot remain unaffected. In the acute disease, the bone will soon become congested; while in the chronic, the slow-paced disease, it will gradually undergo a process of softening, and at last become, perhaps, carious. Then, the fibrous tissue around the joint—that is, the ligaments and tendons of muscles—may be expected to participate in the morbid action going on within. In the acute form, when pus speedily forms, the surgeon may expect to see the same phenomena as is witnessed in the progress of an ordinary abscess.

These ordinary features in the pathology of disease in the synovial membrane will always be modified by any peculiar constitutional disease which may have been their predisposing cause. Thus, if there be scrofula, the characteristics of that affection will be prominent, and the products will be materially modified thereby. Also, if syphilis exist in the constitution, or any other special disease, it will give character to the local malady. But, for a knowledge of these, the reader is requested to turn to those diseases.

Sometimes inflammation, and other diseases of the joint, commences in the textures adjacent to the synovial membrane, and the synovial thickening and softening is a result of that. We have learned that disease often arises in the bone, and, it may be, in the ends of the bones. From the bone, it may gradually extend until the synovial membrane is involved, as in the manner above described. Or, the disease may originate in the cartilage, or in the ligaments, or from some injury external to the joint, which will lead to similar results. But, respecting the cartilage, it cannot be properly said that it is subject to inflammation. For the development of inflammation, bloodvessels are necessary, but none exist in the cartilage. In it the process of nutrition is car-

ried on through the agency of cells; consequently, true inflammatory action is impossible. But this anatomical condition accounts for the fact that the cartilage is liable to suffer when any disease exists in the neighboring tissues. If the supply of blood which comes to the cartilage, although it does not enter, be limited or cut off, the vitality of that structure is at once attacked, and ulcerative destruction will probably ensue. If inflammation or other disease involves those feeding-vessels, in like manner the cartilage will be exposed to danger. But, although the absence of blood-vessels will not allow ordinary inflammation, there is nevertheless a morbid action, which is the result of the adjacent disease. The cartilage may become thickened or softened, or it may degenerate, or ossify, or ulcerate, or actually perish.

There are two notable diseases which belong to the joint: *white swelling*, and *morbus coxarius*. In the former, which is peculiar to the knee-joint, the synovial membrane is principally, at least primarily, involved. In the latter, a disease of the hip-joint, the cartilage is principally concerned, and it is said it commonly originates in that tissue. Certainly, the cartilage is destroyed at an early stage of the disease.

Inflammation and other diseases sometimes arise in the outer tissues of the joint, as the ligaments, the tendons of muscles, the cellular tissue, and the skin; thence extending to the bone, or to the cartilage, or the synovial membrane. The ligaments may become elongated, or the muscles contracted, as above explained, and the integument thickened and discolored; or, on the contrary, it may be preternaturally white, as in the white swelling. Again, as will be at once understood, abscesses may form—indeed, are very sure to form, if the disease progresses. Openings result, and chronic sinuses.

Results.—Of course, at any time during the progress of inflammation, the cause of the morbid action may be removed. Then, if changes too important have not taken place, resolution may follow; but if serious destruction has occurred, or morbid changes been effected, then, although the disease may be stayed, a cure cannot be expected at once to follow. The joint will consequently be impaired, or entirely destroyed, anchylosis being the result. When the motion of the joint is only impaired by morbid deposits, or by contracted tendons, under judicious management the motion

may, after a time, be completely restored. When anchylosis results,—there being permanent union between the ends of the bones, ossific or ligamentous,—of course, restoration is impossible.

But sometimes the disease will run a steady course toward irreparable destruction. And, if the diseased structure be not removed by resection or amputation, the constitution will, sooner or later, succumb to the great irritation and exhausting discharge, which will lead to death.

CHAPTER XL.

Treatment: Rest—Applications—Excision.

Treatment.—This will, to some extent, depend upon the cause of the disease, and will be directed to the stage at which the surgeon is called to treat it. When the inflammation is running high, the treatment must be correspondingly active. One of the first indications is to maintain the limb in a state of absolute repose; also, the body and mind should be in a state of rest. We have seen that nature endeavors to secure this important condition, in fixing the joint by the aid of continued muscular contraction. But this incessant pressure upon inflamed tissue cannot but be provocative of further irritation, and it is therefore in itself an evil. Now, by placing the limb in a comfortable position, in the first stage of the disease, pain will be allayed, and the inflammation stayed, as the muscles will then cease to act; but the limb, exposed to motion made by the patient and by the nurse, resorts to the above objectionable mode of obtaining rest. Then, the muscles being of unequal strength, the joint will gradually be changed in position. To what extent this slow flexion of an inflamed joint may prove disastrous, is well exemplified in the knee-joint, in many cases of articular rheumatism. If the limb could be placed at the first in a position of rest, the muscles would not thus contract, and such serious pathological results would not follow.

The treatment will always divide itself into general and local.

So far as the former is concerned, it need only be said here that it is based on the general principles of inflammation, and will be particularly directed to any constitutional taint that may have been the cause of the disease.

As to the local treatment, the limb having been placed in the position above indicated, endeavors will be made to alleviate and remove the pain, as it is the principal link in the chain of morbid events. "The same trunks of nerves whose branches supply the groups of muscles moving a joint, furnish also a distribution of nerves to the skin over the insertions of the same muscles; and—what at this moment more especially merits our attention—the interior of the joint receives its nerves from the same source." (Hilton.) Such being the case, it can be at once understood that the irritated nerves within the joint may be reached through those nerves which are placed external to it. Hence it is that soothing applications are so generally serviceable. *Hot fomentations*, or *poultices*, in the first stage of inflammation, are most valuable, and will, in conjunction with rest of the limb, be in many cases adequate to arrest the disease. *Anodynes*, alone, or with the hot applications, are also useful. Indeed, all those agents which have been given in the treatment of inflammation may prove beneficial. I have found a solution of Plumbi Acet. most valuable; but it requires to be *strong*, and *diligently applied*. Repeated local bleeding by leeches will often be necessary. If, in the course of the disease, pus is believed to exist, either in the joint or in the tissue external thereto, it should be promptly evacuated by the use of the knife. The theory is well-nigh exploded that it is necessarily most disastrous to open a joint, either in health or disease; but even were it true that the exposure of the interior of a joint to the air would lead to evil consequences, yet, of two dangers, it would be far less than to allow pus to remain pent up, which, by its presence and pressure, would produce disorganization of tissue.

When the acute symptoms have subsided, and there be effusion, other than of pus, in the joint, and also when the action has assumed the chronic form, the application of blisters is indicated. They ought not to be very large, but repeated, first on one side and then on the other. At this stage of the disease hot fomentations and poultices ought not to be employed, unless severe pain

render it necessary, and then their use must be only temporary. I have often seen their continuance lead to disastrous results. In the first stage, they relaxed the tissue, and soothed the irritated nerves; but, being continued too long, they induced passive congestion, and thus prevented a return of the vessels to their natural tone, and a restoration to physiological action of the parts involved in disease. There is at this time a tendency to venous congestion, not alone of the knee, but the leg and foot. An elevated position of the limb will, to some extent, counteract this tendency. Leeches will relieve the local passive congestion as well as the active.

When the disease assumes the form of thickening, and of degeneration of the membrane—when there is, for instance, "white swelling," the treatment will be primarily directed to the constitution; the local treatment will have to be long continued. Counter-irritation by issue or by repeated blisters, will divert morbid nature from the seat of disease, whereby a physiological action may become possible. A very important element in the treatment is well-directed pressure upon the joint by straps or by bandage. Should acute symptoms at any time present themselves, they must be met by appropriate treatment. Rest—protracted rest, and extending over a period of months, perhaps years, will generally be demanded; but, at the same time, fresh air and a change of life, are highly essential to the restoration of the general health. While these are secured, rest of the joint may be also obtained by the skilful use of straps, or by a sling or a crutch, so arranged that motion of the joint is effectually prevented.

When the process of repair is well under progress, some attention should be paid to the preserving of the joint. The patient cannot be allowed to use the joint, but the surgeon should, from time to time, employ passive motion, always being careful not to disturb the work of repair, as it would be better to have anchylosis than to place the limb or the life in jeopardy.

Sometimes the tissues, one or more, are so disorganized, or destroyed by ulceration, that the patient must needs keep to his bed. In such cases suitable splints will have to be applied to the limb, so as to give it support. It has already been said that when pus is found to exist in the joint, it must be treated as in abscess; but it will often occur, that from some reason, such treatment has not been pursued, and the pus, thus remaining pent up, has caused a

very serious amount of ulcerative destruction, involving the membrane, the cartilage, and even the bone. Whatever may have been the immediate cause of the ulcerative destruction, when the joint is thus seriously involved, it will be a question whether restoration may possibly be effected, even with anchylosis, or whether removal of the diseased bone, by either excision or amputation, will have to be resorted to. If the disease is evidently progressing, or continues for a long time without any signs of amelioration, notwithstanding all treatment, there can be no doubt as to the propriety of operation. The continued disease will materially affect the general health, and sooner or later the powers of life will succumb.

The practice of excising joints is of a comparatively recent date, and perhaps there does not yet exist sufficient data upon which to base a correct estimate of its value. No one can question the general principle that, in operating, no more of a limb should be removed than is really necessary. Applying this rule to the matter under consideration, it seems plain that excision ought, whenever possible, to take the place of amputation. To many, a natural limb, even with an anchylosed joint, is preferable to a false one. The position of the patient in life will, to some extent, be taken into consideration, as well as his avowed wishes on the subject. The question of mortality after this operation, when compared with the hazard attending amputation, will also have to be weighed. On this point perhaps there may be a difference of opinion.

I enjoyed the high privilege while in London, in 1856, of seeing the eminent Fergusson (to whom the surgical profession is so much indebted), perform excision of the knee joint, and heard him expound the principles upon which he based his procedure. He presented to his students and listeners several cases upon whom he had previously operated, all of whom had had most encouraging recoveries. The lesson I have never forgotten, nor have I ever doubted the importance of the operation, or the value of resection of the joint, whatever may have been the cause of disease. I have seen cases of resection which ultimately failed, but I was not convinced that the *failure was not due to the treatment pursued subsequent to the operation.* The results of the operation are sometimes surprising. Nature, rid of the diseased structure, which she had fruitlessly striven to repair, rallies again to the work; and often

in a short time, the limb will become to some extent restored, at least the general health is improved. Fergusson has recorded not a few cases where, at the time of operation, there was great emaciation and prostration, but immediately thereafter the strength began to increase, the general health to improve.

Upon one or two points I wish still further to speak in connection with the subject of resection, inasmuch as they are not very well established. Many of the profession seem slow to believe that, in performing excision *the joint is not necessarily lost—that a new one may, and will be created if proper treatment be pursued.* It is the more common belief that the most to be hoped for, is an ossific and firm union between the ends of the bones. And every step which is taken subsequent to the operation, is bent to secure this union between the two bones. After the ends have been sawed off, the bones are brought together, perhaps fastened by metallic sutures; every effort is made to prevent motion, the same as after fracture. In some cases this may be the most promising procedure, *but the higher aim of the surgeon is to obtain a false joint.*

It has been seen (*vide* False Joints) that occasionally after fracture, union does not take place; and that one unpleasant cause of this is continued motion at the seat of fracture. Well, there can be no reason why the same result shall not follow resection of a joint. Indeed, the condition of the parts is favorable to this; the action of the muscles by which the limb is naturally moved, will produce that active motion necessary to the formation of a new joint. Cases are recorded by Hancock and others, in which a very complete joint was formed after an entire removal of the natural joint. And what has taken place can again take place, not in certain joints, but in all.

Another point to which I wish to refer is, that with the joint there may be also the formation of a large quantity of new bone. Much of the bone, from those entering into the formation of the joint, may be excised, and subsequently restored before the joint is re-formed.

To illustrate these points, I will introduce the record of a case which I furnished to the London "Lancet." The importance of the principles under consideration is a sufficient excuse for introducing it here.

RESECTION OF THE ANKLE-JOINT.

To the Editor of the Lancet.

Sir: I had the honor to report in the "British American Journal," in the June number of 1862, a case of "Resection of the Ankle-Joint." The case was recorded four months after the operation. I then stated that I should at the expiration of a year furnish the profession with the final result. The journal in which the case was published has ceased to exist. I therefore take the liberty of requesting a space in the "Lancet" to fulfil my promise. Indeed I venture to think the case of sufficient importance to warrant its publication in your widely circulated journal.

There are two or three points to which I purpose particularly to refer, and which will become apparent as I proceed. These are points regarding which there is at the present time perhaps no settled opinion. The operation was performed in the way recommended by Henry Hancock, Esq., surgeon to the Charing Cross Hospital. Last winter Mr. Hancock, in urging the importance of this operation, referred to the success which had attended the case under consideration, and I think from it it will be seen that conservative surgery deserves to be more fully tested. The young man operated upon was twenty-one years of age, with a constitution in most respects good. The disease of the bones which led to the operation was, I think, chiefly, if not altogether, due to local causes. Having made the single incision through the integument as recommended, and dissected up the flap, the following pieces of bone were successively removed: first, the astragalus, one-half of which was in a state of necrosis, and the other portion in a disorganized condition. Then the external malleolus, after which the tibia was turned out, and a little more than half an inch sawn off; but the condition of the bones above was such that it was deemed necessary to remove more; consequently, the incision through the soft parts having been extended, and the parts dissected from the bone, an inch and a half more of both tibia and fibula were removed. At this time it was recommended by the surgeon assisting me to amputate; but as I had strong faith in Nature's ability to heal, and as the patient had caused me to promise that if there was but a slight possibility of saving the foot to give him the benefit of it, I determined to make the trial. The

upper surface of the os calcis was thereafter also removed to the extent of half an inch by the gouge. The operation being completed, the limb was placed in the fracture-box. By careful measurement of the bones excised, it was found that fully three inches in length had been removed. The space, however, between the bones of the foot and those of the leg was perceptibly diminished by contraction of the muscles of the leg. I confess my anxiety was great to see the result, for I was not aware of any precedent for so extensive a removal of bone. But no artery of any size had been divided in the operation; the diseased bone had been completely removed, and I trusted that the powers of Nature would prove adequate to the task of repair, although so extensive. A portion of the flap, in which was a cicatrix that had resulted from previous sloughing, subsequently perished, leaving a large opening, through which could be seen the end of the tibia. But, notwithstanding this increased work of repair, healing of the whole rapidly progressed. There was no great discharge at any time, no inflammation, no waste of reparative material. Water-dressing alone was used. I mention these facts, because had there been irritation, had there been much discharge, the result might not have been so favorable.

At the end of nine weeks the limb presented the following appearance: A healthy-looking and limited cicatrix, marking the incision through the integument. A very small opening internally, where had been the most sloughing. The foot reduced to almost its natural size, and in a natural position. The bones of the foot have not yet joined with those of the leg. The foot can be moved passively in any direction, yet there is a comfortable degree of firmness, which has been constantly increasing. The patient can move the foot and toes in a natural manner. In a word, there is a prospect of an excellent joint.

Within four months after the operation he could rest the foot upon the ground; within six months he could walk by the aid of a cane, and at the expiration of a year he could run upon it. I saw him on one occasion mount a flight of stairs three steps at a leap. I have recently seen the patient, and found by measurement that there is just two inches of shortening. A boot is worn, with a sole thickened about three quarters of an inch. The ankle

is supported on either side by steel springs, and he walks with a very slight limp.

Now, in this case we have a very striking exemplification of the resources of Nature. Not only is there an extraordinary restoration of bone, but there has also been the formation of a new joint. In order to prevent an ossific union between the bones of the foot and those of the leg, the patient was instructed at an early date to exercise the muscles of the leg, so as to cause active motion. The result now is a very perfect joint. Not a few medical friends, with whom I have conversed about it, cannot credit the fact that there is any motion, being led away with the belief that after excision of a joint there is necessarily a stiff joint. I have reminded such that a very common cause of false joint after fracture is continued motion at the seat of fracture; and if so unfortunate a result follows so simple a cause, in connection with a fracture badly treated, why can we not secure the same result after excision of a joint, by which the natural motion and use of the limb will be retained? This, as I have before said, can be secured by causing the patient to use the muscles, so as to keep up motion. One can only speculate with regard to the provisions of this new joint, and it would be interesting and instructive to examine it; but in this case I do not think a chance will offer as long as the patient lives.

CHAPTER XLI.

Dropsy of Joints: Causes—Treatment. Elongation of Ligaments. Cartilage in Joint: Diagnosis—Prognosis—Treatment. Wounds of Joints: Diagnosis—Treatment. Deformities of the Joints: Varieties—Congenital—Non-congenital—Treatment.

Dropsy of the Joint; Hydrops Articuli.—Sometimes swelling of a joint will take place in such an insidious manner, that the patient will not be aware of it until the enlargement has become considerable. There is an entire absence of pain, or other symptoms which would attract his attention. There may be a degree

of weakness in the joint, but it is more often the result of the dropsy than an early symptom. There seems to be a greater activity in the secreting function than in the absorbents. The former may be increased, or the latter may be diminished.

Predisposing Cause.—This may be some general debility of the system, or a local injury whereby the integrity of the joint was impaired.

Some slight injury may constitute an immediate cause, but frequently none is perceptible.

Treatment, in the main, will consist in the administration of some preparation of iodine and iron. Local applications of the tincture of iodine, or a large blister over the joint, or croton oil, may be used. When these fail, puncturing the joint may be resorted to; and after the fluid has been drawn off, the cavity may be injected with tincture of iodine, reduced one-half with water. Of late years, the practice of injecting tincture of iodine into closed cavities has been successfully followed; into joints, as well as into serous sacs. I remember to have seen the renowned Velpeau, in the *Hôpital de la Charité*, inject a quantity of the tincture of iodine into the peritoneal cavity, after a quantity of fluid had been removed. At this I was more than astonished, and expected to see, on the following morning, inflammation of an active nature; but there was nothing of the kind, and the patient did well. The chronic ascites was quite cured. The iodine, when used in this way, is not intended to create inflammatory action or adhesion, but to stimulate the membrane to a natural healthy action. No doubt, when injected under such circumstances, it merely brings up the action to the natural standard; whereas, had the action of the part before been natural, the stimulus would have produced inflammatory action.

Sometimes support and pressure will assist in restoring healthy action of the membrane.

Elongation of the Ligaments.—This is found existing more frequently in young persons of weak or scrofulous habits; those who live indoors a good deal, and have not food either proper in quantity or in quality. It is also seen in connection with synovial degeneration, either as a cause or an effect. It is one of the predisposing causes of dislocation. It may coexist with inflammation, or with thickening, or with dropsy.

Treatment.—Attention must be paid to the general health. The joint must have rest, and support in the form of a bandage or an elastic cap.

Cartilages in the Joints.—These foreign bodies are so called because they resemble cartilage in appearance, and often in consistence. As to their mode of formation, different explanations have been given; but, as is often the case under such circumstances, there is no single way by which they are produced. They frequently seem to form in connection with the synovial membrane; sometimes upon the free surface, sometimes upon the attached surface, and sometimes in the substance of the membrane. At first there will be a mere thickening of the membrane, which in time will take the form of a distinct tumor. It will be remembered that sometimes, as a result of inflammation, there will be here and there a deposit of fibrinous material, which may become to some extent organized. This is more frequently seen where the membrane folds upon itself, forming a kind of border. The tumor may be produced in this way. In whatever way it is originated, there is at first a thickening, then a perceptible elevation, and then a tumor, which has a comparatively broad base. Gradually, the extent of attachment is diminished, until there is the smallest pedicle. Attached in this way, a slight force will prove sufficient to detach it, such as a sudden moving of the joint. When the growth commences beneath the membrane, the body, when it becomes detached, will present a very smooth surface, being covered with synovial membrane.

These bodies rarely exceed three in number, and often there are only two—sometimes only one. The size varies, from that of a small pea to a size five or six times as great. In form, they often approach to the oval; but there is no particular shape. In consistence, they vary from fatty tissue to bony. They are sometimes of a yellowish color, sometimes of a glistening white. They may be composed of natural or of adventitious tissue; fibrinous, fibrous, cartilage, cartilaginous, fatty, or of bone.

The joints in which they most frequently form are the ginglymoidal—in the knee especially. They may remain attached by the narrow pedicle for some time, and, after they are separated, may remain in the joint without giving any indications of their existence. Taking the knee-joint,—in which they most frequently

are found,—the following is the more common way in which the disease makes itself known. The person is walking, and takes, perhaps, an extraordinary step—perhaps suddenly steps to a lower level—and is instantaneously seized with excruciating pain, and with inability to move the joint in either way. In this condition he may remain for some minutes, perhaps a much longer time, and will at last sink to the ground from exhaustion. All at once the pain may cease, and no further trouble be experienced, except a considerable soreness in the joint. The explanation is simple. These bodies may float about in the fluid of the joint, but are mainly ensconced in some corner of the synovial cavity. At times, they may issue therefrom; but the ends of the articulating bones press them back. But when the limb is made to take an unusual step, one of these little bodies will sometimes be forced directly between the articulating surfaces, so as to cause this most sudden and severe pain in the sensitive synovial membrane; whereupon the muscles, sympathizing with the injured structure, literally spring into action, and thereby spasmodically grasp the foreign body between the ends of the bones, and thus the pain is increased, and hence there continues the inability to move the joint. At last the muscles, completely tired out, may relax, and the foreign body slips away, and the pain ceases; or, the individual, falling down exhausted, or fainting, may have this body dislodged from its unusual position. The repeated recurrence of such attacks will in time give rise to inflammation or effusion, and may lead to disorganization of the joint.

Diagnosis.—The symptoms above described are characteristic of this affection, and are therefore *reliable diagnostic marks.* On examination, the surgeon may at times feel the foreign substance, and it may be made to move from one place to another.

Prognosis.—This must be cautiously given. There is danger of the serious issue above referred to. There is also danger if the body is allowed to remain, and danger when an attempt is made to remove it.

Treatment.—The unfortunate sufferer will not, as a general thing, seek surgical advice until he has had two or more attacks, and there may be, as a result of those attacks, more or less local inflammation. Should there be any such evil resulting from the attack, it must be in the first place attended to.

The surgeon may adopt a course of palliative or preventive treatment, or he may aim to effect a radical cure by a removal of the body from the joint.

If by any appliance the body can be so controlled that it may not be caught between the articulating bones, the surgeon may be satisfied, while the patient will be fully contented. To accomplish this, pressure is frequently applied to the joint by a bandage, which, to allow of motion in the joint, will have to be elastic. Knee-caps are manufactured for this purpose. It must not be too tight, else it will affect venous flow in the limb; yet it should fit closely. When the limb is flexed, the bandage is put upon the stretch, by which means a greater degree of support is obtained, at the very time it is most required; and thus the foreign body is prevented from straying out of its usual place of abode. But not unfrequently this palliative treatment will fail, and the recurring painful attacks will produce most distressing results, and will tend to inflammation and disorganization. The patient will probably become solicitous of more effectual relief—of securing the removal of the foreign body from the joint. Heretofore, and by many even now, it was deemed a dangerous operation to make an incision into a joint. It has consequently been recommended to make an indirect opening, so that none of the synovial fluid may escape. The operation, as usually practised, consists at first in making an indirect incision with a small tenotomy knife. Before commencing, the position of the body to be removed must be definitely ascertained. Should it not lie in the place most convenient to be reached, efforts must be made, by careful manipulation, to get it in such position. When in the knee, the preferable place is on the inner side, at the extremity of the synovial pouch. An assistant should fix the body during the operation; or a fine needle may be made to transfix it. The knife having been passed in an oblique direction to the body, the synovial membrane is divided to a sufficient extent to allow an easy exit of the substance, which will then be made to pass through this aperture, by gentle, well-directed pressure. The knife being withdrawn, the finger will follow its track, so as to close it, that little or no synovial fluid may escape. The body will then be forced out of the joint, and made to occupy a place in the cellular tissue for some days, until the wound in the synovial membrane is quite healed. The

operation will then be completed by making a direct incision upon the body, and removing it. This is the operation more frequently chosen by the surgeon; but sometimes the body is removed at one operation. The former is deemed the most safe, inasmuch as but little synovial fluid can escape. But even should that fluid escape to some extent, it will not be attended with much, if any, danger. (*Vide* Wounds of Joints.) While, on the other hand, a foreign body is forced into the cellular tissue, where it cannot but be provocative of great irritation.

The after-treatment, in both cases, is absolute rest of the joint, and diligent application of cold water.

Wounds of Joints have, until very recently, been regarded as almost or quite fatal to the integrity of a joint. The escape of the fluid and the entrance of air, it was thought, would necessarily produce a degree of inflammation that would certainly impair or destroy the joint. That such terminations have frequently followed wounds of the joint is undoubtedly true; but that such disastrous results must follow as a consequence, there is abundant reason to doubt. The instrument which penetrates to the joint is often small and sharp. The pain arising therefrom is very slight, and *herein lies the danger.* The patient, suffering no pain nor inconvenience, and unaware of the danger, gives little or no heed to it, very likely continuing to use it. Through the wound the synovial fluid has drained off, and continues to flow, so that the joint is not supplied with the necessary lubricating fluid. The friction arising from motion soon induces irritation, which continuing, will terminate in inflammation. The inflammation, therefore, is not the necessary consequence of the wound; but instead is the result of motion in the joint while the parts are unsupplied with fluid to prevent friction. The view that the entrance of air into the open joint is a cause of irritation, cannot be received. Indeed, it is impossible to conceive by what natural law air could be forced into a joint, although open. Atmospheric pressure is quite as great upon the tissue around, as upon the orifice of the wound. We cannot understand any other effect arising from the absence of the fluid than a closer contact of the opposite structures of the joint.

Diagnosis.—The *reliable indication* of a wound into the cavity of a joint is the discharge of the synovial fluid. The degree of *pain*, as well as other symptoms, will depend upon the character

of the wound, and the subsequent irritation from attempts to use the joint.

Treatment.—The essential steps to be taken in the treatment will be inferred from the remarks made relative to the real source of danger—the cause of the inflammation. Absolute repose of the joint, with the ordinary treatment of wounds, is all that is required.

The process of healing will commence and proceed in this case, as in any other wound. Although the synovia may have escaped, yet in due time there will be a new supply secreted by the membrane. When, however, from the extent of the injury, or from injudicious treatment, inflammation has supervened, the treatment heretofore detailed will be pursued.

Deformities at the Joint.—These may result from diseases, as ulceration or softening of tissue, from irregular action of the muscles, from violent displacement or dislocation.

When deformity results from chronic disease of a joint, little or nothing can be done to remedy or remove it. In the progress of such diseases, when it becomes evident to the surgeon that partial or complete anchylosis will result, he should place the limb in that position as to flexion or extension which will, to the patient, be the most useful, or, perhaps, the least unsightly. The position in society of the patient and his own wishes must be fully considered.

Nature will often, in the course of time, remove the obstacles to motion. In all of these cases, irregular contraction of muscles, by which the bones may be drawn into unnatural relationship, should be counteracted, and, if necessary, the unruly muscle divided at its tendon. An apparatus should be specially prepared, by which the limb will be supported, and at the same time the muscles effectually resisted.

Deformities, resulting from a want of uniform or harmonious action around the joint, may be due to *congenital* defects, or from those which have been *acquired*, and which depend upon some disease of the cerebro-spinal system.

Varieties.—Congenital deformities are of two kinds. 1. Those which proceed from arrest or excess of development, from spinal irritation, &c. 2. Those which are caused by simple malposition *in utero*. The former may be hereditary; the latter rarely so.

The former rarely admit of complete relief; the latter generally so. (Holmes Coote.)

The cause of these congenital deformities is, in many cases, intra-uterine pressure. Oftentimes they will be attributed to maternal impressions, but it is the overwise midwife who principally holds this opinion. Mother's marks and deformities will now and then present themselves, just as fruit of various kinds have now and then their blemishes and imperfections. In the experience of the woman during nine months of pregnancy, almost every conceivable impression will be made, being exposed in the natural order of things to a great variety of circumstances, and the imagination can readily associate with the blemish upon the child some one of the many occurrences during her time, especially when under the morbid stimulus of superstition.

The more frequent cause is a departure from natural development, the cause of which may lie hidden. It may have a maternal source, or it may be some circumstance aside from the mother.

The arrest of development may be in certain muscles, or it may be in the cerebro-spinal centres, which, in consequence, fail to govern certain muscles.

The flexors and extensors of a limb are, to a certain extent, antagonistic; but when in a state of health, the balance of power is so complete that they act in perfect harmony. When one muscle or one set of muscles fails to act, either on account of its own inability, or because the necessary nervous stimulus is withheld, then the antagonistic muscle or muscles have the power to rule the limb, and deformity will ensue, as in club-foot. It is possible that undue action of a muscle may be the cause of the deformity; but, speaking generally, it is a want of power in the opposing muscle.

This pathological state of the muscles may exist at the time of birth (congenital), or it may afterwards gradually come on (acquired). But there are certain immediate causes, acting after birth, which sometimes produce a more severe and prompt contraction of the muscles, as in convulsions.

Sometimes the irregular action may be arrested by a strong effort of the will.

Whatever the cause of the deformity, when existing for a time, structural changes will inevitably take place in the tissues com-

posing the joint, thereby complicating the case, and rendering recovery almost or altogether unlikely.

Treatment.—When the deformity is due simply to malposition *in utero*, it may be righted by the unaided powers of nature.

When the deformity is due to irregular action of the muscles, one muscle being more or less feeble, the more early the treatment is commenced, the more likely is it to be successful.

The indications are, to overcome the power of such muscles as produce the deformity. The surgeon cannot stimulate the paralyzed or weakened muscles to their natural power; so he must reduce the power of those which are opposed to them. There are two ways in which this can be done: 1st, by division of tendons; 2d, by mechanical extension, or by both of these means.

Division is to be effected, when practicable, by a subcutaneous incision (tenotomy). For this operation a small tenotomy knife is to be used. This operation is of a comparatively recent date, but is one which can be safely and easily performed, and which will, in a vast majority of cases, afford the greatest relief to the patient; for there is nothing more distressing to a person than deformity. When a tendon is divided the ends will be drawn widely apart by the contraction of the muscle. The hiatus thus made will, in time, be occupied by an adventitious material, unlike the normal tendon, but incorporated with it, and being equally useful.

But sometimes this operation is unnecessary, or is, perhaps, objected to by the friends; in which case protracted extension may be resorted to. By this means the over-powerful muscle is overcome, the bones of the joint are placed in proper relationship, and, after a time, the muscles which had been unable to cope with those opposed to them, regain or attain the strength which is natural. Thereafter the action of all the muscles will be harmonious. When taken at an early age, mechanical extension will often prove adequate to effect a cure. "The removal of a deformity, in general, requires the application of great power, steadily and unremittingly maintained. But the force employed must be so gradual, so gentle, so well adjusted, that it neither pains the patient, nor rubs the skin. If the pressure be too great, the patient will soon find the pain unendurable, when the surgeon will be obliged to relax it, and so he may go on for weeks, and even months, alternately overpressing and relaxing, but making no steady progress towards

cure. For however ineffectual violent extension may be against a firm contraction, there are few, perhaps no tissues, which can resist the application of constant and steady, yet gentle-acting force." (Holmes Coote.) It follows that for some time after the treatment has commenced, there will be no perceptible advantage gained. It is a matter of months, not of days.

Mechanical aid will often have to be employed conjointly with tenotomy. Indeed, in several forms of club-foot, this is absolutely necessary.

In every case where the deformity has existed so long that structural change has taken place in the bone, the process of cure will be protracted, and the result less certain. At least, so perfect a joint cannot be hoped for.

"The occasional non-union of tendons induces me to mention to you two rules which should be always observed. First, never divide a tendon, whether in hand or foot, in the dense portion of the synovial sheath; the retracted ends become adherent to the sheath; there is no re-establishment of the continuity of the tendon, and there is a corresponding loss of motion. In the second place, do not extend the parts too rapidly after operation, for the fear of 'non-union' is not wholly imaginary, even when the operation is performed in the proper place and manner." (Holmes Coote.)

It is necessary to allude to another species of deformity, resulting from weakness, which may be either congenital or acquired. It is not in the muscles where the weakness exists, but in the bones and ligaments; instances of which are seen in the knock-knee, the bow leg, and in the flat foot. They are incapable of sustaining the superincumbent weight, and gradually yield under it, until very considerable deformity exists, and locomotion is attended with great awkwardness, or indeed, it may become almost impossible.

These affections are more commonly the result of constitutional weakness, yet there may, in addition, have been some local cause.

Treatment.—Attention must be paid to the constitution. It is an affection often seen in the children of large towns and cities, who have neither good food nor pure air. In these cases, to supply those requisites to health may be sufficient to turn aside the course of disease. Tonics will, as a general thing, be demanded.

With respect to the local treatment, it consists in giving sup-

port, and when there is actual deformity, such pressure, direct and indirect, as will gradually restore the parts to their natural position. In the young, and when the deformity is slight, a limited time will be sufficient to effect a cure, but in the more aged, and when the deformity is considerable, a protracted period will be necessary. The time will vary from a few weeks to, perhaps, two years.

CHAPTER XLII.

Dislocations: Causes — Classification — Diagnosis — Prognosis — Pathology — Treatment—Indications—Reduce the Principal One—Remove Obstacles—Complications.

Dislocation of Bone.—By dislocation of bone is understood a displacement at the site of articulation of two or more bones. It is ordinarily due to violence. When it is remembered that to allow that play of the limb for which joints exist, there must be a degree of looseness, so to speak, in the joint, that the ligaments must be of sufficient length to permit of the necessary motion; and still more, when we consider the diversified action of the muscles by which motion in a joint is effected, there can be no difficulty, at the same time, in understanding, that a predisposition to dislocation is a necessary consequence of the motion, and the means by which it is made.

Causes of dislocation may be divided into *predisposing* and *immediate.*

Predisposing Causes.—The *period of middle life* in man, when he is ordinarily exposed to accidents, may be designated a predisposing cause of dislocation. At this period the bones possess the greatest degree of firmness. They will not easily bend, as in the young, nor break, as in the aged. So when force is violently used against a limb, the joint being the weaker point, is the most likely to yield. A second predisposing cause of dislocation is a *preternaturally lax condition of the ligaments;* also an *unusual length.* These may be a congenital defect, or they may be the result of disease. Again, some joints, because of their *peculiar form*, are

more liable than other joints, to dislocation. The shoulder-joint particularly, is subject to displacement. Here is a ball and socket joint, at which is very extensive motion. The socket is necessarily shallow, while the articulating surface of the head of the humerus is very extensive. The sweep of the arm in its varied and extensive movements, demands the above condition. To allow this diversified motion the ligaments must be sufficiently free, and this freedom of motion must carry with it a corresponding degree of weakness. Hence it is, that the shoulder-joint is a frequent seat of dislocation. Again, take the radius where its superior extremity articulates with the humerus and ulna. It is by this articulation, principally, that the complicated motion of the hand is allowed, and for this motion there must be a freeness at the site of articulation. The consequence is, the head of the radius cannot resist any great force when it is applied in such a way as to try the strength of its ligaments. A joint may be predisposed to displacement in *consequence of some congenital defect* in the bones thereof. *Paralysis* of one or more muscles around a joint will predispose to the accident, for the bones are held together, not alone by ligaments, but as well by the muscles. Another predisposing cause is *disease, whereby the tissues are ulcerated.* It may be the ligaments, or the cartilage, or the bone. Still another predisposing cause, is the *presence of tumors or morbid deposits*, which gradually affect the integrity of the joint.

Immediate Causes.—There are two, *external violence* and *muscular action.* The violence may be *direct* or *indirect.* For instance, the head of the radius may be dislocated by a fall upon the part, or upon the hand. Again, the shoulder may be put out of joint by a force directly applied to the part, or by its application to the elbow or hand.

Dislocation from muscular action is not of common occurrence, yet it does sometimes occur. In convulsions, or in any case where there is a want of harmonious action, if the more powerful muscles act suddenly, displacement may be produced.

The two causes may act conjointly, in the following manner: by some external violence, the humerus, at the shoulder, we will suppose, is to a slight extent displaced, by external force. Immediately thereupon, the muscles connected with that joint are stimulated to contraction; but owing to the displacement, although

slight, the harmony of action in the muscles is destroyed; some, perhaps, are acting at a disadvantage. The result is that the bone, slightly displaced, is caught by muscles whose power, under the circumstances, is adequate to complete the dislocation. It is by a similar process that a primitive dislocation is converted into a consecutive dislocation.

Classification.—The following are the several classifications given by different writers: *Primitive*, and *consecutive; incomplete*, or *subluxation*, and *complete; recent*, and *old; simple*, *compound*, and *complicated.*

Allusion has been made above to the process whereby a primitive dislocation is changed to a consecutive. To illustrate, take one of considerable interest, occurring in the hip. The most frequent form of dislocation at that joint is upon the dorsum of the ilium. Now, it sometimes happens that, by muscular action, or a secondary external force, the head of the femur is carried from the dorsum into the ischiatic notch. Indeed, when we look at the anatomy of the parts, it is not easy to conceive how *direct* dislocation into the ischiatic notch can take place; and the conclusion is almost forced upon us, that this form of dislocation is always consecutive.

The terms "incomplete" and "complete" are sufficiently plain. It will not unfrequently happen that the displacing force will not be sufficient to entirely separate the articulating surfaces.

Simple, compound, and complicated, have exactly the same signification as when used in connection with fractures. (To which the student may turn.)

Symptoms of Dislocation.—Like those of fracture, they may be divided into such as are characteristic of dislocation, and such as may exist from other causes as well. Of the latter, there are *pain*, *numbness*, *paralysis*, *loss of motion*, and *constitutional disturbance.* Of the former, which are physical signs, there are, first, *change in the entire form of the limb.* It is at once plain, without demonstration, that displacement cannot exist at a joint without its being palpable to any beholder. One species of deformity requires special notice: that is, a change in the length of the limb; it may be shortened, or it may be lengthened. Another symptom, and one of importance, is the *unnatural rigidity of the limb* at the dislocated joint. Neither the patient nor the surgeon

can, to any extent, move the joint. Again, around every joint, in its natural state, are bony prominences. When displacement has taken place, there will be *an absence of the usual prominent points*, and, instead, *unnatural eminences.*

Diagnosis.—The affections with which dislocation may be confounded are *fractures*, *bent bones*, and *sprains.*

The educated surgeon will experience no difficulty to distinguish between a fracture and a luxation; for while the two affections have some symptoms in common, yet there are enough peculiar to each to constitute reliable diagnostic marks. It is only when a fracture is near the joint that a mistake can possibly be made. The most prominent symptom, of both dislocation and fracture, is deformity. Now, when the deformity is due to fracture, the surgeon can readily restore the parts to their natural form; whereas, in dislocation, the ends of the displaced bones are fast locked in their abnormal condition, unless the ligaments have been torn (in which case there is likely to be a compound dislocation). Consequently, reduction to the normal position is difficult. Moreover, although a fracture is easily reduced, it will, with a corresponding easiness, relapse into deformity when unsupported; while, on the contrary, a dislocation, when reduced, will almost always remain so. In other words, *in a fracture, there is a condition analogous to a second joint; while in dislocation, the motion of the natural joint is absent.* The absence of *crepitus* is a negative symptom of some value. (*Vide* Symptoms of Fracture.)

Prognosis and Pathology.—This will be modified by a variety of circumstances. Dislocations of all joints are not equally serious, nor are the several dislocations of the same joint equally dangerous in their issue. Speaking generally, all dislocations, when taken in time, are reducible; and unless some serious complication attend, there need be no fear as to the result. But if a dislocation has existed for some time, grave obstacles may have arisen, which cannot be overcome.

When a joint remains some time displaced, there will be an effort on the part of nature to accommodate herself to the abnormal condition. Bonds of adhesion may form, whereby the bones are securely bound; or a new resting-place may, in part, have formed for the head of the bone. The direction of the displacement, and the degree, will be considered in forming a prognosis.

And again, the amount of injury to the soft parts, or any special complication, will weigh in coming to a decision.

When a dislocation continues unreduced, important changes will take place, and, in time, from absorption and new formation, a degree of motion will be obtained.

Treatment—The Indications.—In the first place, *the general condition of the patient must be attended to;* in the second place, *reduce the dislocation;* and in the third place, *prevent inflammation. The principal thing in the treatment is to effect reduction.*

Should the surgeon be near at hand at the time the accident occurs, he may with little difficulty restore the bones, and with comparatively little pain to the patient, for the parts will yet be lax. But after a little time has elapsed, the muscles will become contracted, and the sensitiveness of the part acute. The patient's fears ought, as much as possible, to be calmed; and should the suffering and difficulty promise to be great, chloroform must be administered. This may be necessary even before examination is made. Should inflammation have arisen, it is not necessary or desirable to wait for it to subside; indeed, perhaps the reduction is necessary, that the inflammation may be arrested. When, however, the inflammation is due to great violence, or previous ill-judged attempts to reduce the parts, then it may be well to wait a few days, that the irritation may subside.

Obstacles to Reduction.—To accomplish reduction, the surgeon must *understand fully the obstacle or obstacles to be overcome.* There can be no greater piece of barbarity than to attempt to effect reduction by brute force, without a knowledge of the anatomy and the function of the muscles. The obstacles which may exist are: 1. *Muscular action.* 2. *Form of the part,—locking of the bones, or held by firm ligaments.* 3. *Morbid adhesions.* 4. *Interposition of tendons or ligaments. The muscular contraction, and the unyielding nature of the ligaments, constitute the most formidable obstacles.*

To overcome muscular contraction, various measures may be resorted to. The cause of the more powerful action of the muscles is the unusual relationship in which the articulating ends are placed. Some muscles are thereby put upon the stretch, while others are rendered inactive from their points of attachment being approximated.

The first principle of treatment which has been generally taught, is to overcome the muscular action by mechanical means; literally, to enter into a contest with the muscles, and to endeavor to overcome them by sheer force, tiring them out. But the surgeon should not resort to such harsh procedure until he has duly considered whether other and gentler means may not be employed to accomplish the same end. At such times, the muscles are exceedingly sensitive, and are quick to protect the joint at the least irritation, especially when the patient is laboring under mental excitement and fear. Hence the importance of quieting the mind and diverting the attention.

Now, it is possible, in some forms of dislocation, to so manipulate the limb that the muscles will not be to any extent irritated, and at the same time the displaced ends will be gradually brought toward their natural position. Sometimes, by dexterous movements, the dislocation may be reduced, and the patient be unaware of its completion; at other times, the ends having been brought almost together, the surgeon can, by a quick motion, cause them to slip into their natural relationship. That this may prove successful, they must be so brought into position that the muscles around the joint will, when they start to act, contract harmoniously; and then, by their united action, the reduction is completed. But should the effort be made before the bones are thus placed, the only effect will be to aggravate and increase the degree of displacement. It is upon these principles that dislocation of the femur upon the dorsum of the ilium is now often treated successfully. It perhaps more frequently happens that this milder and more scientific mode is unavailing, and it becomes necessary to use mechanical force to overcome the action of the muscles, or adopt some constitutional treatment to produce relaxation. To carry out the former, the surgeon will apply extension and counter-extension. This may be done by fixing the body with one hand, and with the other using extension to the extremity of the limb. In this an assistant may take part. Extension may be made by a *close-hitched* bandage. Upon this, extension can be made by assistants or by pulleys. In whatever way the extension is made, whether by hand or by pulleys, it must be done very steadily. It will not do to apply great force at once; rather, the force must be gentle, uniform, and continued, until the muscles are literally tired out,

whereupon the bones may at once glide into place. The extension must be made from the bone dislocated; for instance, if at the hip-joint, the hitch must be applied to the lower end of the femur, and not from the leg below the knee. It has been objected that the application of the bandage to the same bone causes the muscles to contract the more forcibly. This, to some extent, is true; yet they will be the sooner exhausted, while the advantage gained by the more immediate power of extension is of considerable importance.

The direction in which the extension is made will be such as *will cause the head of the displaced bone to traverse in an opposite direction the course which it took at the time dislocation was effected.* The counter extension consists in fixing the body so that the extension will be the more availing.

Constitutional Remedies.—Various constitutional means may be employed to cause relaxation of the muscles. The most important is *chloroform*, and it ought always to be administered when the difficulty is great. But when reduction is sought by manipulation, anæsthetic agents should not be given, for, as we have seen, the muscles act, at the last moment, an important part in completing the reduction. Formerly bloodletting was deemed necessary, but in this our day, no excuse can be offered for a wasteful expenditure of the patient's strength and health. The *hot bath*, *tart. emetic*, *tobacco*, *intoxication*, &c., have been used to advantage, but chloroform takes the place of all these.

The next obstacle to reduction which we have to consider, is the locking of the bones. At the time dislocation is accomplished the ligaments are very much stretched, and if not torn, they will soon recover their natural state, and so will as firmly bind the bones in their abnormal position as they bound them in their natural state. The heads of the bones or the prominences around lapping each other, the ligaments will tenaciously hold them in that condition. There is, therefore, this other obstacle to be overcome simultaneously with the forementioned. Extension will, to some extent, reach this, but the surgeon can *assist very materially by applying a second force.* After extension has been applied for some time, and the muscles are quite subdued, then, *when the bones are locked, by lifting the head of the bone* upon which the extension is being made, the bones will the more easily be brought together at the

joint. In this way the head of the femur may be lifted over the brim of the acetabulum. The proper time at which to apply this second force is when all other obstacles are overcome. Sometimes a sudden jerk or quick lift will secure the desired end.

Another obstacle which may have to be encountered is that which results from effusion and organization of plastic matter, by which the bones have become bound together in their abnormal position. If these be of long standing, to overcome them is most difficult, perhaps impossible. Any powerful effort to reduce a dislocation under such circumstances, is attended often with extreme danger. Results the most disastrous may follow. *Inflammation, laceration of nerves* or *arteries, followed by aneurisms*, are not unlikely results. These adhesions may be supposed to exist after there has been considerable inflammation, whether from the injury or from repeated attempts to reduce the dislocation, and followed by a considerable lapse of time. In such cases, where it is thought advisable to try to effect reduction, the adhesions should be broken up by rotating the limb repeatedly before extension is employed.

A very difficult obstacle to overcome is the interposition of a tendon or ligament. The surgeon can never be sure of the existence of this difficulty. Sometimes the head of the bone is forced through a capsular ligament, and the slit, barely large enough to allow the passage of the head, at once catches it as a button is caught in a button-hole. There will be reason to suspect some such obstruction, when a seemingly simple case of dislocation can not be reduced by the ordinary means. In such cases extension should be made in as many ways as practicable, so as to afford every chance for the head to be extricated. If the surgeon be quite certain as to the cause of the difficulty, he may, by subcutaneous section, divide the parts. To insure success, however, a perfect knowledge of anatomy as well as of the pathology is indispensable.

In all doubtful cases, whatever the cause of doubt, when it is uncertain whether there is morbid adhesions, or the interposition of any substance, the surgeon ought to explain to the patient the nature of the case, and the doubtfulness of success, so that he may choose for himself the course he would wish to be pursued, and thereby bear a part of the responsibility.

Unlike fractures, dislocations, when reduced, will, in almost every

case, remain reduced. If the ligaments have been torn, a retentive apparatus may be required, but it is quite the exception. Attention must be given to prevent inflammation. Rest of the joint for a time must be secured.

Compound, and other complicated dislocations, will receive, in addition to the treatment of dislocation, the same treatment as is given to complicated fractures.

CHAPTER XLIII.

Surgical Affections of Arteries: Inflammation—Coagulated Fibrin in Vessel—Pathology. Aneurism: Divisions—Varieties—Causes—Symptoms and Diagnosis—Prognosis—Course—Results.

Surgical Affections of the Arteries—Classification.—The affections of the arteries which the surgeon may be called upon to treat, are *wounds*, *inflammation*, *deposit of fibrin within the vessel*, *suppuration*, *ulceration*, *contraction of the vessel*, *dilatation*, *thickening*, *transformation; and arising out of these*, *the important disease of aneurism.*

Wounds of Arteries.—So much has been said in connection with hæmostatics, respecting wounds of the arteries, that but little requires to be said here. Indeed, it is only necessary to speak of those wounds *which only partially sever the vessel.* In such cases the process by which nature closes the vessel cannot proceed, and the bleeding consequently continues. The surgeon may often cause the bleeding to stop by *completely dividing the artery.* If that fail, the usual course will be pursued. (*Vide* Hæmostatics.)

Pathology—Inflammation of the Arteries.—Inflammation of the arterial coats generally assumes the chronic form. The fact that the inner coats of the artery are not supplied with vessels, but are supplied otherwise with nutriment, would lead us to expect that the phenomena of disease therein would materially differ from disease in other structures, and observation corroborates this supposition. Indeed, it would seem that the so-called inflammation, and some other affections, are due rather to certain conditions of

the blood than to the ordinary causes. Whether we take the membrane lining the cavities of the heart, or that lining a remote artery, the appearance of the tissue, when affected by what is called arteritis, is very unlike ordinary inflammation. The early and most constant product of this disease is a fibrinous deposit, which may be found diffused upon the inner surface of the vessel to a greater or less extent. Now, the absence of the *vasa vasorum* warrants the belief that this deposit must be derived directly from the circulating blood as it passes along. There are certain conditions of the blood in which the fibrin will readily separate from it, although in seemingly healthy circulation, and be deposited upon the inner coat of the artery or heart. Any prominent point will be the earlier site of the deposit. It is often seen upon the cords and valves of the heart. When this deposit is made upon the arterial coats, it cannot but be a cause of embarrassment to the vessel. The arteries continually and regularly contract and dilate, as wave after wave passes along from the heart. Now, the fibrin, when deposited upon the coats, must interfere with this natural action of the artery. And it is not unlikely that the symptoms which characterize this disease are due to this interference with the healthy action of the vessel. That is to say, the deposit is the first step in the disease, and is the cause of what is commonly designated arteritis.

The pressure of coagulated fibrin upon the inner coat will soon derange normal nutrition, in whatever way it may be carried on; first in the inner coat, and soon after in the middle, and perhaps in the external coat also. In the substance of the coats and between them will also be deposited fibrinous material, by which they will be thickened. The fibrin thus deposited is subject to the same changes as when deposited elsewhere. The nature of these changes will depend upon the character of the fibrin, the manner in which it may be affected, and the vitality with which it is endowed. Upon these will depend whether organization or degeneration shall follow, or whether vain attempts at organization shall be followed by degeneration, or by a transformation of both adventitious and natural tissue.

It will be seen that two general pathological results may follow the deposit, one in connection with the fibrin itself, the other in

the coats of the vessel. But these changes will ordinarily progress simultaneously.

One very common effect of the morbid deposit is softening of the arterial coats, which generally are thickened at the same time. A further result of the softening will often be dilatation of the vessel. The coats are unable to resist the pressure made by the constantly coursing blood, and so gradually yield to its force. If the artery be to a considerable extent involved, to the same extent will dilatation take place, and if the disease be limited, so will the dilatation. If the whole circumference be affected, then dilatation of the whole circumference will follow. These facts are mentioned particularly, because they are important as the *pathological conditions of certain kinds of aneurisms.*

Again, the deposit often undergoes certain changes. Perhaps, in coagulating, the substance is converted into what is called atheroma, a substance composed of "albuminous and earthy particles, of crystalline plates of cholesterine, of an imperfect fibrous texture, and of oil-globules." (Gross.) The atheroma thus formed will soon involve the coats of the vessel in the same disease. With the atheroma there is often softening; but when there is simply atheromatous deposit, dilatation of the coats may take place. Like the softening, this may be limited in extent, or, on the contrary, an extensive surface may be involved. Often there will be plates of this substance in the coats, presenting an oval or rounded form. In connection with this disease, as well as when there is softening, there is not unfrequently ulceration of the coats. And when the tissue composing the coats is destroyed by the ulcerative process, there is formed an aperture, through which the blood will try to find its way as it rolls along in successive waves. The ulceration may be limited to the inner coat, or it may extend to the middle and external coats. Here, again, we see how aneurisms may be formed from arteritis. The blood passes through the opening made by ulceration, and gradually causes distension of the adjacent tissues, until a space—a sac—is formed for a collection of blood.

Then, again, the adventitious matter may be transformed into bone, in the form of plates of the size of a pin's head or a fingernail. Sometimes the whole circumference of the arterial tube is the site of ossific deposit. This is more commonly seen in aged

persons. I have seen those in whom the arteries of the arm were entirely bony, and consequently there was no pulsation. Of course, when bony matter is deposited in the coats, contraction cannot take place. When the deposit is in the form of plates, the action of the arterial coats will be embarrassed, and ulceration is likely to result from the irritation produced by the margins of the plates as each wave of blood passes along. Not unlikely, the bony deposit is at first uniform, but the successive contraction and dilatation breaks it up into several plates, as a swell would break up ice. It is then that the edges of the plates, being hard, will produce ulcerative destruction at their edges, which will be followed by an escape of blood, and thereafter by an aneurism.

Ulceration, whether resulting from one cause or another, may be confined to the internal coat, or it may extend to the others. When the internal alone is ulcerated, the blood will sometimes, instead of distending the outer coats into a sac, separate the internal coat from the middle for some distance; likewise, when the middle coat is also perforated, the blood may separate the middle from the external coat to an equal extent. In both cases, sometimes the blood will find, at a point some distance removed on the distal side, an ulcerated opening, by which it will gain admittance again into the circulation. But whether this is the case or not, this separation of the coats by the intrusion of the blood is known as the *dissectiny aneurism.*

Again, the fibrin, being possessed of a high degree of contractility, may, especially when deposited upon or in the whole circumference of the artery, so contract as to diminish the calibre of the vessel. In consequence of this, the blood, being hindered in its course, will press upon the artery at the cardiac side, and thereby induce dilatation, especially if there be any softening—a condition which may coexist. In this way may be formed another kind of aneurism.

Fibrin, deposited in the arterial coats, may undergo other changes. It may become very hard, or it may cause thickening, without leading to any further evil results. But sometimes it may completely close up the artery, so that the blood can no longer pass along. The results of this may be very serious. A limb may thereby be deprived of blood. Again, the clot may undergo deteriorating changes—may disintegrate, and the small particles,

passing along for a certain distance, will at last be arrested by the smallness of the vessel, and there induce inflammatory action. Or it may be the cause of a more serious—a constitutional affection; it may constitute a blood poison, which will lead to most serious diseases, perhaps pyemia or some similar affection.

The fibrin deposited may possibly degenerate into pus; this, however, is more likely to follow wounds which have involved the arteries. Sometimes the fibrin will coagulate, and completely fill up the arterial tube; but in the middle of the clot, a portion will degenerate into pus. And thus an abscess may exist within the artery, and yet the pus never find an entrance into the circulation. Indeed, the fibrin will form an impassable barrier, by which the pus will be prevented from entering the blood. The artery being completely destroyed, the abscess will take the ordinary course, and gradually find its way to the surface of the body.

Thus, it will be seen that the disease known as arteritis cannot be separated from the various other affections of the vessel; that, indeed, it stands related to them as cause to effect.

The pathology of the disease seems comparatively plain; but it is most insidious, and may run a protracted and even fatal course without a knowledge of its existence being had by the individual or his medical attendant. From certain constitutional defects or tendencies, such diseases may be inferred, but can never be definitely diagnosed.

The consideration of this disease, then, but prepares us for another, whose symptoms are patent; a disease which, of all others perhaps, is the most serious, and demands the most discriminating treatment. I refer to aneurisms.

Aneurisms.—By an aneurism is understood a sacculated tumor communicating with an artery, and filled with blood, which mingles with that within the artery.

Division.—Several divisions of aneurisms may be made. First, into *true* and *false*. A *true aneurism* is one which has for its sac one or more of the coats of the artery. A false aneurism is one which has neither arterial coat for a covering, but whose sac is formed by condensed cellular tissue. The former is the result of chronic disease, as above detailed, and is the most common. The latter is generally the result of a wound, which has in part severed the artery; but it may also arise from laceration by overstretch-

ing, or from ulceration, or from an abscess. The solution of continuity in the structures superficial to the artery may become closed; but the arterial coats do not—cannot, indeed, from the continuous contraction of the vessel. Consequently, the blood gradually finds its way into the cellular tissue, which, becoming condensed, constitutes the sac to the aneurism.

Again, aneurisms are divided into internal and external; that is, those which are situated in the cavities of the body, and generally receive the attention of the physician; and those which are external to the body, and quite within the reach of the surgeon. Then there are used the terms *mixed; diffused; circumscribed; dissecting; varicose; aneurismal varix;* and *aneurism by anastomosis.*

Varieties.—There are a variety of shapes which the aneurismal tumor may present in the course of its formation and development. Thus, it may be *sacciform*, or *fusiform*, or *cylindroid*, or *varix-like.* The form which it assumes will depend, in the first place, upon the extent of arterial tissue involved; then upon the situation in the body; and then upon the character of the tissues against which the tumor will press as it grows in size. In the sacciform, the mouth is comparatively small. In the fusiform, there is contraction of the tube, and dilatation above it. In the cylindroid, the arterial tube is generally dilated.

Number.—There is generally but one aneurism existing at a time, yet occasionally there are several coexisting.

Causes.—The great *predisposing cause has been fully given*, but in addition the following may be mentioned: The *male sex;* probably because he is more exposed to those causes of constitutional disease. The *period of life between thirty and fifty* is considered a predisposing cause, in a certain sense. *The lower limb* is predisposed to aneurism. The *laboring class* is more frequently affected, also probably *because of exposure. Intemperance* is said to predispose to the disease; that is, to those diseases which result in destruction or disease of the arterial structure. *Large arteries* are more frequently the site of disease.

Exciting Causes.—Some *sudden and violent exertion of the body or limb*, whereby the arterial tissue is overstretched. Again, a *wound made in a part* where is arterial disease. And *ulceration, from any cause.*

Symptoms and Diagnosis.—First, there is the elastic pulsating swelling. As each wave of blood comes sweeping along, the blood rushes into the sac with more or less force, and strikes upon the outer walls thereof. The momentum is communicated to the adjacent tissue, and can be felt by the finger when placed immediately over the part. However, this pulsation is not always a reliable symptom, for the same will be felt when any tumor is placed over an artery, whereby it receives the impulse of the arterial current. When the blood first finds its way into, and occupies the sac, the tumor will be more particularly elastic, and the diagnosis more certain; but when layers of coagulated fibrin have successively formed upon the inner surface of the sac, the elasticity and fluctuation will be absent or modified, whereupon it will bear some resemblance to other tumors. An aneurismal tumor may be reduced in size by placing the finger upon the artery at the cardiac side of the tumor, but when the pressure is removed the tumor will regain at once its previous size. *This is a valuable diagnostic mark.* And if pressure be made upon the distal side of the tumor, so as to arrest the blood flowing from the aneurism, the tumor will become more firm, and perhaps increase in size. Another important symptom is what is known by the French term *bruit de soufflet.* This peculiar sound is produced by the blood as it is hurried into the sac through its mouth. It may often be heard by simply placing the ear over the part, or by using the stethoscope. In using the stethoscope, however, it must be remembered that the pressure of the instrument may so act upon the artery through another tumor, as to lessen the current and give rise to the same sound. If the tumor, not an aneurism, be overlying the artery, it may be raised by the hand away from the vessel, whereupon all resemblance to an aneurism will at once disappear. But when it is a chronic abscess this cannot be done.

The history of the case will materially assist in the diagnosis. An aneurism contains only fluid at first, and is soft; after a while it becomes more firm. But an ordinary tumor will generally be the same in consistence at all times, while an abscess is at first hard, and subsequently soft. I have seen a psoas abscess mistaken by a surgeon for an aneurism, and by another surgeon, for a hernia. But the history and behavior of a hernia are very unlike those of an aneurism; and so also it may be said of a chronic

abscess. Pain is often present, sometimes is very great, but in the latter stages the tumor may, by pressing against the nerves, induce paralysis. The integument over the aneurism may remain natural, but if it approach the surface, the skin will gradually lose its natural appearance, and present a dark red or livid color. Venous circulation in the limb will be impeded, leading to œdema and a reduction of the temperature.

Constitutional Symptoms.—The system is conscious of some serious derangement in its economy, and there will be an unexplainable state of depression, bodily and mental, for which the patient cannot account, and for which, there seems to the surgeon no adequate cause. The stomach becomes weak, and there is an indifference or actual aversion to food. Then comes great restlessness, sleepless nights, failing strength, and perhaps exhaustion.

Prognosis.—This must always be given with extreme caution. All the circumstances of the case must be fully considered—the general condition of the patient, the predisposing cause, the present stage of the disease, &c. A spontaneous cure may take place, but such cases are rare. Treatment may result in cure, but there are many failures.

Course and Result—Pathology.—The time occupied by an aneurism to run its course varies very much. In a brief period of time it may reach a fatal end, or nature alone may in a short time effect a perfect cure. On the contrary, years may elapse before the final termination in death. The course of the disease is by no means uniform.

The several ways by which aneurisms may form have already been detailed. In order to follow the subsequent progress of the tumor, it will be well to take the sacciform aneurism, which has more distinctly a mouth, body, and fundus. It does not matter whether it be a true or a false aneurism. At every pulsation of the heart, the blood enters the sac. The quantity which enters and the force will depend upon the size of the mouth. At every pulsation the sac is filled and the walls exposed to pressure. The tendency is, therefore, to gradual enlargement of the sac. But the pressure made by the blood in entering is not diffused over the whole inner surface of the sac, but is directed to a point directly opposite the mouth. The current striking this point, will necessarily be turned, and in every direction. Now, other things being

equal, the sac will enlarge at the point where the current strikes the wall. But the place of dilatation does not depend alone upon the force of the current, but also upon the firmness of the opposing structures without the sac. At those places external to the sac where the tissue is yielding, there will dilatation the more readily take place; and on the contrary, where it is unyielding, there the dilatation will be stayed. Hence it will be seen, dilatation may take place in any direction. And practically such is found to occur. Sometimes the tumor extends to the distal side, and sometimes towards the cardiac side, but the latter is less frequent.

From the above it will be seen that there is at all times within the sac a direct current of blood, and several indirect currents formed by the blood regurgitating after striking the wall of the sac. It follows, in consequence, that the blood will in some places be in a more quiescent state than in others; that although it is agitated, it is not moving so rapidly. Now, in those places of the sac where the blood is comparatively at rest, the tendency of that fluid to coagulate will begin and continue to manifest itself. Separated from the volume of blood, the fibrin will part from the other constituents, and coagulate upon the inner surface of the sac. Thus it will be found that layer after layer will form in that portion of the sac where there is the least moving of the blood. Indeed, upon the whole surface, deposition may gradually take place. Nature, true to herself, is even here acting by means of the fibrin, to arrest the course of disease, and to effect repair. And occasionally the effort is successful; the sac being gradually filled by successive layers of coagulated fibrin, and the blood no longer finding space to enter. But this process is frequently interrupted, if not quite turned aside, by the power of disease. Sometimes the clots of fibrin are detached and moved about in the sac by the currents of blood. These clots may pass out into the arterial current, and being carried on, give rise to other mischief. Or one may be caught in the mouth of the sac as it is being carried out, and there remain. When this happens, it forms a favorable obstruction to the inrushing blood, and upon it fibrin will be deposited, generally until the mouth is completely closed. Thus a cure may be accomplished. There are other ways by which a spontaneous cure may be effected. As the aneurismal sac enlarges, it may press upon the artery, either to the cardiac or the distal side, or more directly

upon the vessel. It will be understood, from what has been said, that to lessen the current of blood—to diminish its force, is to offer advantages for cure. Hence it is that the aneurismal tumor, restrained from without by dense tissue, may, by pressing upon the artery, so diminish the volume of the blood, that a comparative stillness of the blood within the sac will be secured, and thus a cure promoted. Sometimes, indeed, the artery itself becomes obliterated. Again, the rapid growth of the tumor may give rise to inflammatory action in the part, involving more or less of the sac, but sufficiently great to assist in the elaboration of the adhesive lymph by which the sac becomes filled. Occasionally the inflammation runs so high as to cause occlusion of the artery, and the formation of an abscess, by which the whole morbid mass is got rid of. But this result is very rare. Sometimes the aneurism, becoming *diffuse*, that is a true aneurism, after a time, becoming false, from the original sac being ruptured or ulcerated, the escaped blood will coagulate around the vessel, and thereby effect a cure; but in order to have this issue, the aneurism must be small and have a small mouth.

If a spontaneous cure be not effected, and no remedial measures reach the disease, the sac will eventually approach the surface of the body, or to some cavity within the body. The method of approach resembles that of the pointing of an abscess. "Where the aneurism opens into a serous cavity, the membrane thereof will be found lacerated. When it bursts through the skin or mucous membrane, the tissue will be found attenuated, and that finally, a small opening had been made by absorption."

CHAPTER XLIV.

Treatment of Aneurisms: Three General Methods—Compression—Digital Compression—Treat by Flexion—By Manipulation—By Ligature—By Hunter's Method—By Brasdor's—By Wardrop's—by Injections—By a Current of Electricity. Varieties: Varicose—Arterio-venous — Treatment. Aneurism by Anastomosis.

Treatment.—We have seen in every instance where spontaneous cure is effected, that the fibrin acted an essential part, and that without it cure could not seemingly have taken place.

The surgeon in treating aneurism must take the infallible guide which the operation of nature gives to him. It has been seen that in order to coagulation of fibrin within the sac, the blood must be in a comparatively quiescent state, not absolutely at rest, but so little agitated that gradual deposition of fibrin may take place. And it is fibrin alone that is required; coagulated blood is not so firm, and more especially, some of its elements may decompose. It is fibrin alone that can effectually close up the sac. Consequently, to secure the desired end, the blood should not be altogether cut off from the sac. On this point I would be specific, as it is not a fact generally recognized.

There are three general methods of treating aneurisms. By the first, *the circulation of blood is retarded* in its flow to the sac. By the second, *the blood is entirely arrested.* By the third, *something is administered generally or applied locally to cause coagulation of the blood.* In the first method, *pressure* is applied; in the second, a *ligature* is used to the vessel; while in the third, *some medicine is exhibited.* Of these three modes, the second is least deserving of recommendation. Independently of the danger attending the operation, which is not a little, it is abundantly plain that the preferable mode of treatment is by pressure, and at the same time such other means as will retard the flow of blood into the sac. Because, thereby the volume of the blood is not so great as to prevent coagulation, while there is supplied the necessary quantity of fibrin to form the clot.

There are *two general ways* by which the arterial flow may be lessened in the affected part. One is by acting on the heart itself—controlling its action; the other is by local means, as pressure upon the artery. Anything that tends to increase the heart's action must be steadily avoided. Bland diet and drink. Rest of body and mind, are important ingredients in the general treatment. And then the internal administration of drugs which will reduce the action of the circulation, as digitalis. These constitutional means are always important; but to the physician, in the treatment of *internal* aneurism, they constitute the sole agents to which he may resort.

Pressure.—The surgeon in treating external aneurism will, in the first instance, try local treatment by pressure. There are several methods by which this can be applied. By *bandaging the limb*, commencing at the extremity; by *direct pressure* upon the tumor; *by pressure to the artery* at the *cardiac*, or at the *distal side* of the tumor with the instrument; by digital compression, and by flexion. And, failing in these, by the application of a ligature to the artery.

With respect to the first, bandaging, there can be no doubt that when properly applied, it will, by keeping the limb in a comparative state of rest, and by lessening the arterial flow through the limb, and especially into the aneurismal sac, promote the deposit of fibrin in laminæ upon the inner surface of the sac.

Pressure directly applied to the tumor, unless at the same time to the artery above, is of doubtful utility. It cannot be recommended. But pressure upon the cardiac side of the tumor cannot be too highly spoken of. By this is commonly understood instrumental pressure, which is quite different from digital compression. This treatment is based upon the correct principle, that a comparatively slow formation of a fibrinous clot, is the surer way to effect a cure.

The method of treatment by *compression* is of old date, but to Irish surgeons of comparatively recent date, must principally be given the credit of proving the usefulness of the system. It is always important to so use the pressure as to avoid arresting the venous flow. "The compressors now in use are made on the principle of exerting pressure upon a small space, without any circular constriction of the limb. They consist of a plate or trough, which

is applied to the lower surface of the thigh" (supposing it to be a popliteal aneurism), "at the point opposite to the artery, and a pad supported on this plate by a strong lever or arm, and movable in all directions. The lever stands well away from the thigh, and the instrument is kept in position by the compression which it exercises. When applied, it is screwed down upon the artery until the sensation communicated by the aneurism to the hand is considerably lessened, say diminished about one-half, and is left so until the patient is sensible of inconvenience from it." And "it is better to commence with very mild pressure, to change the place of its application frequently, and to give the patient such intervals of complete repose as may refresh his spirits and procure him good sleep. The management of the compressor should be intrusted to some one who knows the course of the artery, and can judge of the direction in which pressure should be applied to command it. The course of the artery can be indicated by a line drawn down the limb with caustic, and any intelligent patient or nurse soon learns where to apply the pad." (System of Surgery.) The pressure should never be continued so long in one place as to incur the slightest risk of sloughing. Fortunately incessant pressure is not necessary.

"The time required for the success of the compression treatment varies remarkably. In twenty-six successful cases reported in the Medical Times and Gazette, the time varied from sixty hours to eight months, the average being nineteen days. In some of the protracted cases the cause of the delay has been the inefficient way in which the treatment has been carried out. Thus in the case of a young woman who was under Mr. Prescott Hewitt's care, in St. Joseph's Hospital, on account of popliteal aneurism, some years ago, the disease remained stationary, notwithstanding the constant application of pressure for months, but was cured in a few days after her transference to the care of a different nurse. It was discovered that the previous attendant had been in the habit of allowing her to remove the instrument and walk about the ward. Usually when a limb is examined after the successful use of compression, the artery above the tumor shows no trace of its action. The tumor is generally quite firm, being filled with laminated coagulum; but sometimes a channel is seen, through which circulation has gone on in it. All this will be seen to be identical with

spontaneous cure. Enlarged anastomosing arteries are generally discovered, and this enlargement is usually and rightly regarded as one of the earliest and best symptoms of commencing cure." (System of Surgery.)

"One great advantage, however, of the treatment by compression is, that when it fails it seldom fails totally, for if it does not succeed in curing the aneurism, yet in almost all cases it places the disease under more favorable conditions for cure. The obvious reason is, that it produces enlargement of the collateral vessels, and thus obviates the tendency to gangrene."

"As to pressure on the distal side of the sac, I have nothing to say, never having seen a case in which there was any temptation to use it. Its uncertainty and danger are so apparent, that it should never be used where compression or ligature can be applied above the tumor; but in aneurisms at the root of the neck, it may be in some cases worthy of a cautious trial." (System of Surgery —T. Holmes.)

Digital Compression.—"The treatment of aneurism by digital compression is of very recent origin. It has sprung directly from the successes, and it must be said, also from the failures of the treatment by mechanical compression. The first recorded case in which digital compression was successfully employed for aneurism appears to be that of a patient treated by Mr. Greatrex, in May, 1844, and whose case was recorded by that surgeon in the Medico-Chirurgical Transactions for 1845." Compression by the fingers was used in conjunction with the tourniquet.

But in 1848, Dr. Knight, of New Haven, United States, for the first time employed compression of the femoral by the fingers as the sole means of cure. "He obtained the help of a number of assistants, who relieved each other, two and two every half hour, maintaining continued pressure to an extent which arrested pulsation in the tumor. At the end of forty hours, the tumor was one-third smaller, hard, and pulseless. Compression was stopped, the cure was complete, and four months afterwards the tumor could hardly be felt.

"The merit of strongly insisting upon the value of digital compression, and studying its applications to surgical treatment, with a success which fixed the attention of European surgeons, is undoubtedly due to Vanzetti (Professor of Padua). These early

successes were speedily followed by others equally remarkable. In July, 1856, a female patient came under the care of Professor Giappi, of Padua, the subject of aneurism of the ophthalmic artery. The case was one of great severity. The eye projected on to the cheek; it was motionless; the cornea was infiltrated and opaque; the sight was gone. The pulsating aneurismal tumor could be felt by introducing the finger between the globe of the eye and the roof of the orbit; the bruit could be heard loudly. The carotid was compressed, for periods of a minute or two, and with frequent intervals, by the convalescents of the ward and by the patient herself. Pressure continued for more than a minute produced fainting. Nevertheless, at the end of one day there was a visible improvement, and at the end of four days all pulsation had ceased. Four months afterwards, the eye rested and moved naturally in the orbit; vision was restored, the patient remaining only somewhat short-sighted, and with the pupil slightly dilated. A second case, in which a formidable aneurism of the ophthalmic artery, in a patient the subject of aortic and cardiac disease, was cured by digital compression, was published in 1858, by Drs. Vanzetti and Scaramuzza. Intermittent compression of the carotid by the finger was here also employed for five minutes at a time, and cure was effected by seven hours and twenty minutes of compression, spread over eighteen days. These brilliant successes, real triumphs of conservative surgery, supported as they were by abundant and irrefragable testimony, sufficed to place digital compression amongst the most precious resources of surgery in the treatment of external aneurism.

"The subsequent experience of surgeons who have employed this treatment since Vanzetti, affords numerous instances of cure, unrivalled for simplicity, painlessness, ease, and rapidity, in the records of the treatment of aneurism by other means.

"It has been objected to the digital mode of treatment that, from the considerable number of assistants required, it could only be carried out in certain large hospitals, and then at great inconvenience. The objection is, however, of no great force; for, under such circumstances, assistants are rarely wanting, and in more than one case the patient has been able successfully to complete the cure by the unaided pressure of his own fingers. And although a full staff of eight or ten assistants are sometimes required, yet a

smaller number will often suffice. Most surgeons are, I think, agreed that the pressure should, as a rule, be intermittent. The opposite practice produces occasionally some rapid and brilliant cures; but it tends to procure coagulation *en masse* of the contents of the aneurismal sac, with its accompanying dangers, while the intermittent treatment favors the safer form of laminated fibrinous deposition." (System of Surgery—E. Hart.)

The foregoing quotations are so much to the point, that no excuse need be offered for introducing them here.

This principle of pressure, digital or otherwise, is no doubt capable of being applied to cases which heretofore have been deemed quite beyond the reach of surgical aid. In the London Lancet, June 11th, 1864, is recorded a "case of aneurism of the abdominal aorta, which was cured by compression of the artery immediately above the tumor," by Dr. W. Murray, of Newcastle. Pressure was applied by the ordinary horseshoe tourniquet, above the tumor, one blade over the spine. The patient was put under the influence of chloroform, because of the severe pain attending the use of pressure. It was continued two hours, the first time, without any apparent result. Three days after, it was again employed, and continued for five hours; but during that time the instrument would occasionally be displaced. "Its removal showed that now very little pulsation existed in the tumor." "Beyond a little shivering and numbness, with coldness of the feet and legs, nothing of an untoward nature followed. In the evening, after a most careful examination, I failed to detect the slightest pulsation in the tumor or in the aorta below it." "Six days after, collateral circulation was so fully established that the patient could walk with but slight sensation of numbness. Within a fortnight, he was seemingly quite well." Now, it must be confessed that this is a wonderful case. It was reported to the Royal Medical and Chirurgical Society, and the truthfulness is fully attested as to diagnosis and the result. Certainly, the march of our profession is onward, and still onward.

Treatment by Flexion.—Again, I prefer to give the admirable account of this mode found in the System of Surgery by T. Holmes:

"The simple bandaging of the limb in acute flexion, the patient being kept at rest, may occasionally succeed in curing aneurisms

situated at the bend of the limb, as in the popliteal space or the elbow, and possibly in the groin. This plan of cure had been previously tried, but the merit of first demonstrating its success is fairly due to Mr. Ernest Hart. All that is requisite in this treatment, is to bandage the limb, from the toes nearly to the knee, with a roller, and then to turn the roller round the thigh flexed at an acute angle; the limb should then be bent upon the pelvis, and the knee rested against a pillow. In Mr. Hart's case, the cure had made considerable advance after the first day of the treatment, and was complete on the fourth day; on the seventh, the patient was moving about.

"The cases best adapted for the trial of flexion are the simplest. In those cases where the tumor is not of very large size, where the parts covering it are not much inflamed, nor the joint involved, and where, as far as can be ascertained, the tumor is seated on the superficial face of the artery, we may anticipate benefit from flexion. If the flexion of the limb entirely, or almost entirely, suspends the pulsation of the bruit, this treatment may be trusted by itself; otherwise, a compressor must be applied to the artery above, in aid of the flexion. But the compression need not, in such a case, be applied with nearly the same severity which would be demanded in an ordinary case. A very slight amount of pressure will often serve; and if the only advantage of this simple and nearly painless proceeding were to spare the patient the annoyance of severe pressure, it would be no slight one. There are, however, many cases in which the aneurism will be entirely cured by it, without the smallest risk either to life or limb."

Treatment by Manipulation.—The principle upon which this method is based, is by breaking up the laminated clots of fibrin, a piece of which may be caught in the mouth of the sac, and so lead to its complete closure; or it may be sufficiently large to occlude the artery on the distal side, whereby a cure may be effected. But this procedure often fails, and is attended with much risk from the pieces of clotted fibrin passing into the circulation.

Treatment by the Ligature.—The application of a ligature to the artery for the cure of aneurism should not be hastily resorted

to, not until all other means have failed, and there must be a reasonable prospect of success following the operation.

There are three general ways familiar to surgeons, called respectively Hunter's, Brasdor's, and Wardrop's. Hunter's method consists in applying the ligature upon the cardiac side, at some distance from the tumor. It will be remembered that in the true aneurism the arterial coats are very generally in a state of chronic disease. Now, to cut down and apply a ligature to a vessel thus diseased, would be to increase the danger already so imminent to the life of the patient. Hunter conceived the idea of obviating this danger by ligating the vessel at a point as far removed from the tumor as can be done, so as to lessen the probability of the coats being involved in disease. It is true Hunter failed in his operation, but the failure was due to the flat ligature which he employed.

Before proceeding to apply a ligature, the following points must be duly considered. First, there must be collateral circulation. To secure this there must be a branch above the place of ligation, which anastomoses with a branch below the aneurism. Through these the part beyond will be supplied with blood, and if such do not exist, that part will perish for want of blood. These branches will very soon accommodate themselves to the increased quantity of blood which will seek to flow through them. Again, there requires to be a space between the place at which the ligature is applied and the branch above, in which a plug of fibrin may form, and by which the tube will be made impervious. Another thing to be considered before operating, is whether there is a second aneurism, because such would indicate extensive disease of the arterial tissue, and the operation could not be considered warrantable. And again, if the patient be aged, but little hope may be anticipated of recovery.

In performing the operation the principles detailed in connection with the subject of Hæmostatics will be observed.

The immediate effect upon the aneurism is to cause its partial or entire disappearance, the walls being more or less collapsed. As collateral circulation is established, the blood will flow up and into the sac, to some extent. But this cannot be regarded as an untoward occurrence, for as we have seen, a limited supply of fibrin conduces to the formation of a fibrinous clot. Yet not un-

likely, if the sac remained empty, its walls might unite by adhesion, as sometimes follows the emptying of an abscess.

Brasdor's Operation.—Sometimes the location of the aneurism is such that the ligature cannot be applied on the cardiac side. When such is the case *Brasdor's operation* is sometimes performed; that is, the ligature is applied to the capillary side of the tumor. This stoppage of the arterial current below the aneurism will very soon lead to a more rapid deposit of fibrin within the sac, and ultimately to a cure.

Wardrop's Operation is occasionally adopted. It is only performed when the aneurism is placed near a bifurcation, and a ligature cannot be put on at the cardiac side. And consequently it is applied to one of the branches. The result aimed at is a lessening of the arterial flow into the sac, and thereby the cure.

Treatment by Injections.—This is adopted to produce coagulation of the blood. The agents more commonly employed are acetate of lead and the tincture of iron; the perchloride is highly approved. The operation is attended with some danger, and although coagulation of blood in the sac is the immediate result, yet the cure is very uncertain. Very serious inflammation often follows the injection. This, if controlled, may itself lead to obliteration of the tumor. The fact that the aneurism may be treated by compression in many cases will prevent the frequent adoption of this course.

To perform the operation "the best instrument for the purpose is the small graduated syringe, with screw piston and glass body, made for the purpose by most instrument makers, and also used for subcutaneous injections. In performing the injection, it is necessary first to establish accurate compression of the artery above and below the tumor, so as completely to arrest the blood in it. The pointed trocar is plunged perpendicularly into the tumor, care being taken on the one hand to enter the cavity, and on the other not to transfix it, both of which accidents have happened to experienced operators. The success of the step is indicated by the issue of *arterial* blood, an indication which should be looked for. The canula is now screwed on to the trocar, and so much of its contents as may be thought necessary, ejected by successive turns of the piston. The compression of the artery on the cardiac side of the sac should be continued for an hour." (System of Surgery—E. Hart.)

Treatment by passing a current of electricity into the sac, has been successful, but is not deserving of more credit than that just given to the injecting of coagulating fluid. The clot is formed suddenly, and will likely soften after a little. Inflammation is also a frequent effect.

Treatment of aneurism by medicines internally.—Drugs may be given to cause coagulation, and at the same time to reduce the heart's action. They may be used alone, or in conjunction with local treatment. Space cannot be afforded, in a work on the principles of surgery, for this subject, it being strictly a medical subject.

Among the several kinds of aneurisms which were given, are the *varicose*, *aneurismal varix*, and *aneurism by anastomosis.*

Varicose aneurism and *aneurismal varix* are spoken of together in Holmes's System of Surgery, under the title of "Arterio-Venous Aneurism," and with the following definition: "Under this title are included the forms of aneurismal dilatation of an artery communicating with a vein.

"Varicose aneurism consists of a circumscribed consecutive aneurism, which communicates with the artery on one side and the vein on the other; the vein is always tortuous and dilated, sometimes to an enormous extent. Aneurismal varix presents a simpler condition. Adhesion has occurred between the artery and vein at the point of communication; there is no intervening aneurismal sac, and the blood is projected directly from the artery into the vein at each pulsation. Here also the veins connected with the diseased part are greatly dilated, and it is owing to the embarrassment of the circulation thus produced that the injury commonly becomes the cause of distress to the patient, and claims the care of the surgeon.

"Both of these forms of arterio-venous aneurism may originate traumatically, as the effect of violence, or spontaneously, as the result of disease." "By far the most frequent cause is the unskilful performance of venesection at the elbow; but any other punctured wound, the impact of a small shot, injury from the fragment of a comminuted fracture, and, it is said, even simple contusion, have led to this condition."

Treatment.—"The treatment of aneurismal varix and varicose

aneurism must be mentioned separately. That of aneurismal varix presents great difficulties. In many cases, indeed, the disease manifests but little tendency to advance; and where this stationary condition exists, surgical interference may well be omitted." In all cases, the surgeon should try compression, direct and indirect, in the different ways. Indirect pressure is the most likely to prove salutary. Injecting coagulating fluid may be cautiously tried. When all other means fail, a ligature must be applied above and below the place of communication.

The treatment of the varicose aneurism will be essentially the same, with this addition: the sac which here exists must be laid open, so that the opening into the artery can be found; after which, ligature above and below will be applied.

Aneurism by Anastomosis.—This affection is commonly treated of in connection with aneurisms, yet, strictly speaking, it is a tumor, and ought to be considered in connection with other tumors. There is not a morbid condition of the tissue, but rather a morbid growth of the vessels. It is not the arteries only that are affected; the capillaries and the veins may, instead, be the seat of the disease. Such being the case, the disease and treatment will be considered in the chapter on *tumors*.

CHAPTER XLV.

Surgical Affections of Veins: Remarks. Phlebitis: Symptoms—Treatment. Entrance of Air into Veins: Symptoms—Treatment.

Surgical Affections of the Veins.—This portion of the vascular system is liable to disease, as are the arteries. In many respects, however, the affections of the veins are dissimilar from those of the arteries. This fact might be expected, because the two systems are quite unlike, both anatomically and physiologically; and because the blood circulating in the one differs from that in the other: one being arterial, the other venous; and one passing from the heart in distinct waves, the other passing toward the heart in a more equable stream. There is one peculiarity, with respect to the coats, that requires to be noticed. In the artery is a well-

developed elastic and muscular coat, while in the vein it is far less appreciable. The walls of the veins are much thinner; and when the vessel is emptied, it at once is collapsed and flabby. Again, veins are more superficial than arteries. All of the foregoing facts would lead us to expect a dissimilarity in the diseases peculiar to each. This is particularly so in respect to inflammation. While chronic inflammation, or a diseased action closely resembling it, is so common in the arteries, the inflammation which attacks the veins is almost always acute.

Acute Phlebitis is a disease of serious import. It is attended with violent symptoms, and is often followed by fatal consequences. The disease often affects a number of veins simultaneously, and, it is said, always extends toward the heart.

Phlebitis is often confounded with coagulation of blood within the veins (see Pyemia), which may be a curative process, or be due to some morbid state of the blood. When coagulation takes place, very serious effects may follow; yet such is not a necessary rule. But when true inflammation arises in the venous tissue, it constitutes always a most serious disease. The inflammation is suppurative, and partakes much of the character of erysipelas. Indeed, by some it is looked upon as a variety of erysipelas. It will generally be found that the state of health is much below par, and that upon the reception of some injury involving the veins, generally some laceration, the disease was initiated. The inflammation is diffuse, the whole of the coats being involved, and often the tissue around also. Imperfect clots of fibrin may form in the vessel, and soon after disintegrate. The products of disease will be found in the tissue around the vein, as serum and corpuscular lymph, which will degenerate into an ill-conditioned pus, and which will be in small quantities, scattered through the part.

Symptoms.—They are, in most respects, the same as are seen in phlegmonous erysipelas. The prostration is very great. The part in which the inflammation is located will present an œdematous appearance. The pain will be principally along the course of the vessels, where will also be sometimes a degree of redness.

Treatment.—As the constitution is principally affected, at least the vitiated state having been a predisposing cause, it will require immediate consideration. Stimulants of the strongest kind will often be required, beef tea, &c. To the part, warm fomenta-

tions; and if pus be collected, free incisions must be made, that it may escape. (See Phlegmonous Erysipelas.)

Adhesive Phlebitis.—This scarcely requires a separate notice, as it is but a form of the healing process.

Entrance of Air into wounded Veins.—Now and then it happens that during the performance of a surgical operation, there suddenly is heard a hissing sound at the place where incisions have been made. This sound is due to the entrance of air into a vein whose coats have been divided. In carrying on the operation the cut in the vein is by chance made to open, whereupon the air rushes in, passes towards the heart, and causes most alarming symptoms, sometimes death. The explanation of this unfortunate accident is simple enough. It almost always occurs in connection with wounds about the neck or axilla. In order to have the air enter the vein, it is necessary that at the time the wound is opened the patient should inspire. The expansion of the chest in inspiration is always attended with the entrance of air through the air passage, but should another passage present itself, the air will likewise enter by it. The open vein affords another channel under the foremention circumstances. In the same manner a wound into the pleural sac will sometimes allow the air to fill it, and thereby cause collapse of the lung.

Symptoms.—These are in many respects, those of collapse. Sometimes there is only a momentary trembling or shudder, and the patient is dead. Cases are recorded where the patient "expired instantly without either sigh, groan, or struggle." In all cases the heart is seriously affected, beating irregularly, often violently. The breathing is embarrassed, sometimes sighing. Sometimes there are convulsions.

The cause of these symptoms would seem to be the presence of air in the right cavities of the heart. The heart is designed alone to pass along, and force from it, a fluid substance. But here is a gas, upon which the organ is impotent to act. The valves are not acted upon by it, and the air, when the heart contracts, rushes back and forth, instead of being propelled onward. Sometimes the quantity of air is so great as to completely paralyze the heart by over distension of the auricle. There will soon be formed a frothy mixture of blood and air, which it has been thought might prevent its passage through the capillary structure of the lung.

But the causes of death seem to be in the heart. At least *post-mortem* examination supports that view.

Treatment.—In the first place, when operating, as in removal of a tumor about the neck, great care should always be taken not to open a vein. And when such should unfortunately occur, to see that the orifice is not dilated. After the air has entered, the treatment will be based upon the acknowledged fact that the air cannot pass through the heart. Could the blood be forced into the right auricle, the air giving place, it would be well. Rubbing the limbs, therefore, towards the heart will be advisable, to quicken the venous circulation. If the brain is suffering, and syncope present, the body should be placed in the recumbent posture. Stimulants must be administered, also the galvanic battery employed.

In those cases where the action of the heart is overcome, it is recommended to inject warm water into the heart. "The nozzle of the syringe is to be inserted into the vein of the neck, and water injected toward the heart. The precautions and the additional means are: 1st, To raise the neck above the level of the heart; that as the water is forced down, the air in the heart may be raised by it. 2d, To open a vein in the neck and evacuate the blood in it; that as the air ascends during the injection, it may find space in the higher veins. Inject two ounces at a time, with enough, but not too much force, carefully, that no air enters. Galvanism maintained at the same time." (C. H. Moore, System of Surgery.)

DIVISION V.

MORBID GROWTHS.

CHAPTER XLVI.

Morbid Growths: Division—Analogous—Heterologous—Fibrous. Diagnosis — Treatment — Fibroid — Fatty — Cartilaginous — Myeloid — Osseous—Three Kinds — Exostosis — Osteophyte — Osteoid — Cystoid — Glandular—Vascular—Sarcomatous.

Morbid Growths—Tumors.—Although morbid growths and tumors are placed as if synonymous, it may not be generally admitted that there is a necessary connection between them.

In the first place let us endeavor to have a distinct understanding as to the meaning of morbid growths. In the first chapter, on nutrition, the subject of *natural* growth is alluded to. But what is meant by *unnatural* or *morbid* growth? I am disposed to adopt the views of Virchow in this respect, and to regard unnatural growth or new formations simply as a deviation from the normal growth. He says, "We may, therefore, with trifling restrictions, *substitute for the plastic lymph the blastema of the earlier, the exudation of the later writers, connective tissue with its equivalents as the common stock of germs of the body*, and directly trace to it as the general source of the development of new formations."

A tumor, in its broadest signification, includes a variety of morbid operations. In one sense, all tumors are morbid growths. To elucidate the principles it will be preferable to classify *tumors*, give the cause of each kind, and at the same time, point out the difference between them.

Division of Tumors.—First, they may be divided into analogous and heterologous. The ordinary interpretation of these terms is, that the *analogous* tumor is one whose structure bears a likeness to some tissue of the body, although it may be unlike the tissue in which it has grown, and from which it derives its strength. *Hetero-*

logous has been applied to such tumors as have nothing in common with any natural structure of the body; this, at least, is what the name implies. An analogous tumor has generally been regarded as a benignant one, and the heterologous tumor as malignant, the type of which is cancer. But these long-recognized views cannot be regarded as strictly correct. Indeed, if we adopt the views of Virchow, we cannot regard every growth as an offspring of natural tissue; and who can say positively where the natural verges into the unnatural? *Lusus naturæ* of various kinds, monstrosities, malformations, superfluities of parts, &c., are every day to be seen, both in the animal and vegetable world, and so it is in the human organism, although in a less appreciable degree; built up of innumerable single cells, which have been in the order of nature created and developed, and which, having begotten offspring, ultimately die. The body is made up of these independent lives, each of which performs its circle of duty, and then passes away, being succeeded by other similar creations. But, as the child may in one or in many respects be unlike the father, so these cells may to a greater or less extent be dissimilar from their parents. It is when the young cell deviates from the character of the parent cell that heterology may be said to have commenced. (Virchow.) This has more commonly been regarded as a transformation of tissue. And very often the change in the individual cells is that from one kind into another natural kind. But when the change is into structure unlike any tissue in the *natural body*, it may not be regarded as a transformation.

The new formation may be limited to a few cells, or a circumscribed part; or a more extensive district may be changed; or even a whole organ, or muscle, or other individual tissue, may have departed from a state of nature. Attending this change, there may be no deviation from the natural *dimensions;* or, on the contrary, there may be hypertrophy, or there may be atrophy. But more generally, in connection with a transformation, there will be an addition, and consequently an hypertrophy. When an organ or tissue is no longer used, the structure will become both transformed and decreased in volume. And *when the hypertrophy is limited to a circumscribed spot, so as to cause an unusual prominence, the term tumor may be properly applied.*

Speaking broadly, then, a morbid growth is a deviation, more

or less great, from natural repair of tissue (nutrition). Instead of only a repetition of tissue, which has, in the order of nature, perished, there is an increase. This increase may be in accordance with physiological laws (natural growth), or it may be a wild and wayward shoot—a fungus.

In the consideration of tumors, this principle will be found to be ever applicable, although in many cases much modified.

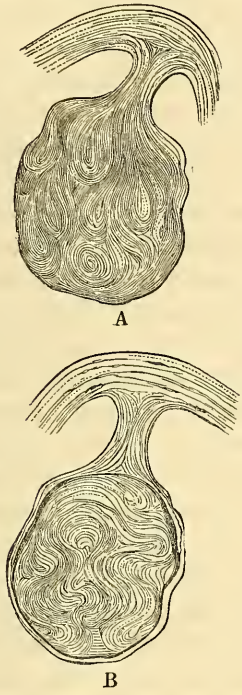
Tumors, again, may be divided according to the nature of the morbid structure; first, into those which are *solid*, and those *containing fluid*. A more practical division is one based upon the actual constituents of the mass, their appearance, and their consistence. Space cannot be given to a complete discussion of all kinds of tumors; but attention, at least, will be given to such as are of the most importance to surgeons. The following varieties will be considered: fibrous, fibroid, epidermic, fatty, cartilaginous, osseous, myeloid, cystoid, glandular, vascular, cancerous.

Fibrous.—This form may appropriately be considered first, as it is a very common kind. Indeed, the fibrous element is found in almost every kind of tumor. A fibrous tumor is generally distinctly marked, and is separated from the tissue in which it is imbedded by a well-marked division. The origin of the fibrous tumor is not always discoverable. Perhaps the more frequent cause is some injury, in consequence of which a small quantity of fibrin is deposited, and which gradually undergoes development. The tumor is never very well supplied with bloodvessels, and its growth is slow.

The Form.—It may present a variety of shapes, the form being moulded by the degree of firmness in the tissues around. It may be round or oval, or pyriform, or in the form of a polypus. The consistence is not always the same; this will depend upon the amount of fibrous element actually composing the tumor. Sometimes the tumor will be made up of several smaller ones, which, in growing, had coalesced and become incorporated. The whole will present a lobulated appearance.

Internal Appearance.—When a fibrous tumor is divided by the knife, it is generally found to present a whitish appearance, with the fibres in bundles traversing the mass. These fibres sometimes present a concentric form. Examined by the microscope, they are

found to resemble closely those of normal tissue. Among the fibres will be seen a few elongated cells.



Habitat.—The parts of the body in which this tumor is most frequently met are the nose, pharynx, uterus, the nerves, the bones, and near the joints; yet they are often seen in other parts.

Size.—It may attain to a very large size. Being of slow growth, it may,—as, for instance, in the uterus, where it can be accommodated by the yielding tissue,—become of immense size, and yet the constitution be but little affected. In time, however, by its weight and presence, it will lead to death.

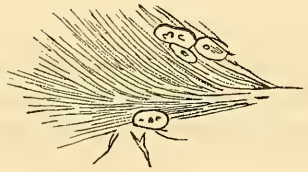
Diagnosis.—The surgeon will notice the locality, the shape, the density, the fact that it is slow of growth, without pain while growing. Excepting when it is located in bone, attention to the above points will enable him to distinguish the fibrous tumor from enlarged glands, from cysts with thick walls, from fibroid growths,

from cancerous formations; all of which are the tumors to which the fibrous sometimes bears some resemblance.

Treatment.—"In the treatment of fibrous tumors (not including those of the uterus), excision is the only available remedy, and had better be resorted to without delay. The method must vary according to the seat of the tumor. Simple enucleation is rarely possible in those within the nerves, bones, or lobules of the ears, though in the first two it may be very often worth attempting." (System of Surgery.)

Fibroid Tumor.—This tumor was first thus called by Paget. It closely resembles, in appearance and consistence, the fibrous. But in behavior it is quite unlike the fibrous. The latter, when removed, rarely returns, being essentially a local disease, so that when it is extirpated the whole system is freed; but the fibroid manifests a decided tendency to return, and sometimes in increased numbers. From this pathological fact, it would seem that the constitution had originally been impregnated with a morbid element, or that the local growth had before its removal imparted to the constitution the fatal power to reproduce the unnatural growth.

The microscope discovers numerous cells in the fibroid mass, which bear a closer resemblance to those of cancer than to those which are seen in the fibrous tumor. Moreover, every successively recurring growth manifests a more malignant behavior than its predecessor. Hence, this formation has been regarded by pathologists as a connecting link between the class of innocent and that of malignant tumors. As might be expected from the existence of the more numerous and the caudate cell, the tumor has a more generous supply of bloodvessels, and the growth of the tumor is consequently more rapid.



Diagnosis.—When the primary tumor exists, it will be impossible to say that it does or does not belong to the fibroid class. A tumor with the outside indications of a fibrous growth, but which grows rapidly, will always be regarded with suspicion, and as one likely to recur. Subsequently, the microscopical appearance of

the primary tumor, and the reappearance, will bear convincing testimony as to its character.

Treatment.—Very often, the patient seeks to have a tumor removed only on the assurance of the surgeon that it will not return. But in no case should he positively declare that a growth will not return. And when its growth has been rapid, there will be the greater caution necessary. In performing the operation, care should be taken to completely extirpate all of the morbid tissue around the more perceptible morbid mass. In every case, notice must be taken whether there be anything which may, by causing irritation, tend to promote the growth, and, when possible, to remove all such. Sometimes pressure, judiciously applied, may to some extent retard the growth.

Epidermic Tumor, or Epithelial.—Every day, examples of this class may be seen, in the form of warts, corns, &c. The growth is morbid in this respect. The layers of epithelial scales gradually accumulate in a circumscribed space, until the thickening assumes the form of a tumor, or vegetable-like growth. A common situation for them is at the anus, and opening of the vagina, caused by irritating discharge. They may be isolated; or clustered together; sometimes actually coalesced, and bearing resemblance to the cauliflower excrescence peculiar to epithelial cancer.

Diagnosis.—It may be mistaken for an epithelial cancer. Epithelial cancer may appear about the genitals, but is more commonly in the form of chimney-sweep's cancer. In other places, also, both malignant and non-malignant epithelial growths may form. For the distinguishing marks of cancer, see that disease.

Treatment.—Complete excision is the only remedy; and generally, there will be no return. Caustics may be used instead, to procure removal. Cleanliness will, as a general thing, prevent their formation. Respecting corns,—epithelial growths upon or about the toes, and which are generally due to the pressure of ill-made or tightly-fitting boots, in connection with the irritating perspiration of the part,—I have space only to make a few remarks. The first and essential thing is to remove the cause. If pressure be quite prevented, in most cases the corn will cease to grow, and entirely disappear. Paring may be practised to advantage, being careful not to cut so deep as to wound. I have found friction, to a great extent, to be obviated by the daily application

of a little sweet oil, with daily ablution. Sometimes the corn is exceedingly painful, either from it being inflamed at its base, or from the presence of a nerve in immediate contact with the corn. In the former case, cooling and astringent lotions will be required. Sometimes a drop or two of pus will form; if so, it must be let out. In the latter case, I have often found the application of nitrate of silver stick have the effect of permanently removing the pain. Should the pain, however, remain, it may be necessary to divide the nerve-trunk a short distance from the tumor.

Fatty Tumor, or Lipomata.—This tumor is not of unfrequent occurrence. Whether examined by the naked eye or the microscope, the fatty tumor exactly resembles normal fat. The cells are quite alike, and the chemical constituents in both cases consist of oleine and margarine. Sometimes, however, the latter is in excess. Entering into the formation of the tumor, there may be more or less of fibrous tissue. The greater the quantity, the more firm will be the tumor. Fatty tumors may form in any part of the body, but are more frequently seen where fat naturally exists—as in the back, neck, and thighs. Several may coexist, but more often there is but one. It sometimes grows to a very large size: even to sixty pounds, it is recorded. The tumor is commonly surrounded by a cyst.

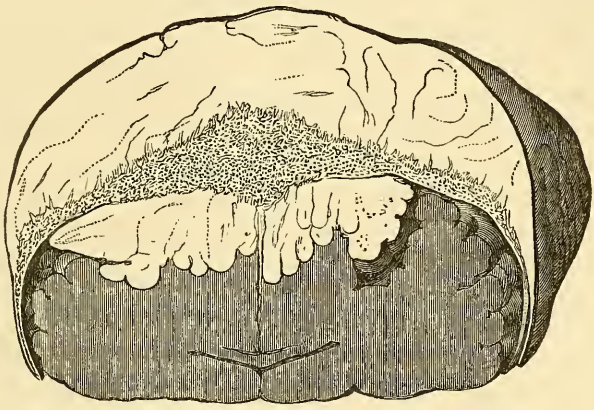
Diagnosis.—The growth is mostly always slow, and it is characterized by a doughy sensation to the fingers. It must be remembered that certain regions of the body are more likely to be the seat of its formation. The tumor sometimes changes from one site to another, owing to the lax nature of the capsule around. Thus, it may gradually gravitate from the groin to the thigh, or from the perineum to the scrotum. (Paget.)

Treatment.—Excision ought, as a general thing, to be resorted to without delay. If a number exist, it may not be possible to remove all; but the one most obnoxious may be removed. If not removed, and growth continue, the pressure upon the adjacent tissue, or the great weight, may lead to exhaustion and death of the patient.

Cartilaginous Tumor, or Enchondromata.—The following account is principally derived from Paget's System of Surgery.

While this tumor is most frequently met with in connection with bone, it is now and then met with in the parotid gland and

the testicles. By far the most common site is on the phalanges and the metacarpal bones. It presents an irregular or nodulated appearance. To the touch, it is hard and resisting, as a general



thing. When cut into, the tumor will seem as if composed of several tumors bound together by connective tissue. The whole is of a bluish white and glistening appearance. In most respects the substance resembles, both to the eye and with the microscope, the fœtal cartilage. In the tumor, ossification may here and there be taking place; or, on the contrary, there may be some points of softening. The whole tumor occasionally becomes bone. The softening may be due to degeneration, and there may be several cavities filled with fluid.

Causes.—These are sometimes hereditary. Now and then it is due to an injury. It may arise from the exterior or from the interior of a bone, and often begins in early life. The growth is always slow, and attended with no pain. The cartilaginous tumor is often "mixed." "Thus, nodules of cartilage are not very rare in fibrocellular tumors; the cartilaginous tumors in or near the parotid

gland have commonly an intermixture of glandular tissue; many of those in bones are mixed with myeloid structure, and in the testicle, cartilage and medullary cancer have often occurred in an apparently single tumor." (System of Surgery.)

Diagnosis.—Its situation, extreme hardness, its lobulated appearance—all will assist the surgeon to arrive at a correct decision. It may be mistaken for scirrhus, or a lymph-gland filled with calcareous matter. But scirrhus is not an inhabitant of the same part of the body as the cartilaginous. And glands with calcareous matter do not regularly grow like the cartilaginous.

Treatment.—Removal is the only remedy. This is sometimes difficult from the capsule being firmly adherent to the surrounding parts. In the parotid region the lobules may dip down into the deeper regions, and even surround important vessels and nerves, rendering the removal extremely difficult, perhaps impossible. When such a condition is unfortunately met with, a portion "may be left, with a good probability that it will not increase." As a general thing, when removed there is no recurrence.

"*Myeloid Tumors* are distinguished by their containing or being chiefly composed of minute structures, similar to those of fœtal marrow or diploe." "The myeloid tumors affect especially the bones, and it is not yet certain that they ever occur as primary growths in any other structure, though tumors much like them have been found in the breast and other parts." "Like the fibrous and cartilaginous, a myeloid tumor may grow either within a bone or on the surface of one; unlike them, it is more frequently found as an interior growth." "When not encased in bone, they usually feel firm. Compressible, slowly resilient and 'fleshy;' very few are harder than these words imply, but some are much softer, easily broken, like ordinary granulations." They may widely vary in appearance and consistence. In the interior of the mass may be one or more cysts, containing various fluids. "The most distinctive microscopic structures of myeloid tumors are many-nucleated bodies, cells, or masses, or disks, resembling cells. Of these, the greater part are oval or roundish"—"their nuclei, from two to ten or more in number, are oval, small, well defined, nucleolated."

Causes.—There is no cause which is common. They ordinarily grow at mature life. Their growth is slow and without irritation.

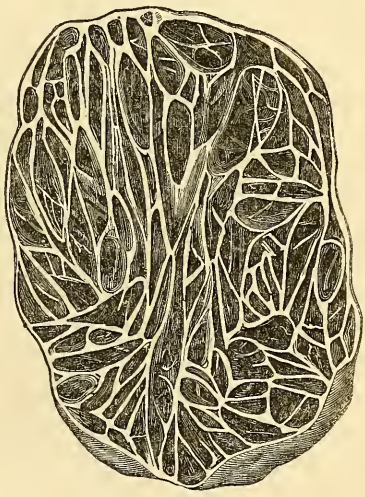
Diagnosis.—"The diseases most likely to be confounded are cysts, fibrous or cartilaginous tumors, and cancer of bones." It will not be forgotten that the myeloid tumor is more frequently internal, and when external it is softer and more vascular than the fibrous. It is slow of growth and free of pain, unlike cancer.

Treatment.—This is in most respects the same as for the fibrous. Recurrence is very uncommon.

Osseous Tumors.—The division of osseous tumors, as given by Jones and Sieveking, will probably be found the most practical, viz., exostosis, osteophytes, osteoid.

Exostosis.—This proceeds from the bone or its periosteum. The form varies; it may be broad and flat, or round and prominent, with a narrow neck. It may attain to the size of a hen's egg. There may be but one or there may be several in the same bone, or in different parts of the osseous structure.

The density varies; sometimes it is very hard, constituting ivory exostosis, or it may be soft, cancellous, forming the spongy exostosis. The ivory form is more prominent—more decidedly a tumor, while the soft is often merely a circumscribed expansion of the bone. Sometimes the growth is in the medullary canal, when it is called an *exostosis.*



Cause.—This is often a blow, or some other injury.

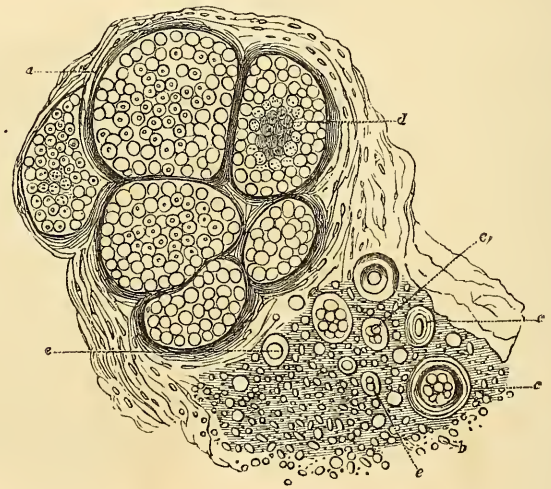
Osteophyte.—This differs from the preceding, in that it is easily separated from the bone, from which it has grown. It is more properly a tumor. The osseous formation is independent of the bone, except that it grows under its influence. It may be found in connection with diseased bone, and may often be attributed to the disease, or rather the efforts which nature will from time to time make, to heal the disease, but which will not have been properly supplied.

Osteoid Tumors.—Rokitansky regards these as cancerous in

their nature, being a cancerous growth with an ossific base. The tumor may be regarded as one which partakes of both the bony and fibrous formation.

Diagnosis.—It will be exceedingly difficult at times to distinguish the osteoid tumor from a true cancer of the bone. Indeed, it would almost seem that a distinct line of demarcation cannot be drawn between them.

Treatment of Bony Growths.—"In the treatment of these hard osseous tumors, excision is the only fit remedy for those on the vault of the skull. But it should not be undertaken unless it is certain that the tumor is increasing, or for some equally good reason, for the extreme hardness of the bone makes the operation difficult, and not a little dangerous." "Occasional cures of such tumors by necrosis and spontaneous separation may justify, in some instances, the practice of exposing their most prominent



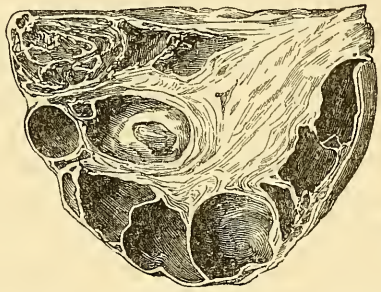
part, and destroying it with some caustic, in the hope of killing the whole mass, so that it may exfoliate."

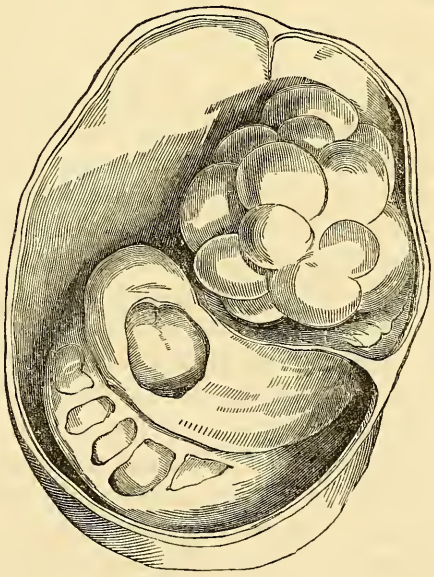
"There is no probability of renewal of growth after the removal of an osseous tumor, and even when the base of the attachment is left, it is not likely to grow again."

Cystoid Tumors.—This is one of the most important classes. Indeed, Paget, in his System of Surgery, divides all innocent tu-

mors into cysts and solid tumors, and among the former he has a large number, viz., *serous*, *synovial*, *mucous*, *sanguineous*, *oily*, *colloid*, *seminal*, &c.

Speaking generally, cystic tumors are composed of two parts, the cyst and the contents of the cyst. The nature of the contents varies much, and it is this variety which gives the several names above mentioned. The contents do not always remain the same; indeed, as a general thing, they undergo changes in consistence and in color. When the fluid is serum-like, the tumor is called serous; and when it resembles mucus, it is known as a mucous cyst, &c. Cysts are called





compound or proliferous when two or more are found coexisting. These multiple growths may all be primary, but more often they

are found as parent and offspring. Such are properly proliferous cysts. They are particularly seen as morbid growths of Graafian vesicles of the ovaries. However interesting these may be to pathologists and even to surgeons, it is not possible to dilate upon their nature here.

Paget particularly describes proliferous cysts with vascular growth, which "are most frequently found in or near glands, especially the mammary, labial, thyroid, and prostate glands." He says the walls are formed of thin connective tissue, smoothly lined within, and externally closely adherent to the surrounding parts. The cyst may contain any kind of fluid until the peculiar growth occupies its cavity instead. This vascular growth commences from points which gradually extend until the whole cavity is filled. Continuing to grow, the cyst is gradually distended till it is destroyed, and the mass presents an appearance much like the excrescence of a cancer. The consistence and color vary much.

Diagnosis.—It is important to distinguish it from cancer. The absence of symptoms peculiar to cancer, and the healthy state of the parts immediately around the cyst, as well as of the constitution generally, will enable the surgeon in most cases to render a correct diagnosis.

Cause.—With regard to cysts generally, which we have seen may contain one of a variety of fluids, there are several ways in which they may form. A normal cell, as in the ovary, may be gradually distended until a tumor is formed. Again, a duct of a sebaceous or a mucous follicle may become obstructed, and the natural secretion, gradually increasing and becoming changed, may so dilate the duct that a cyst will result. Then a cyst may arise from a collection of fluid in the cellular tissue; many of the cell-walls break down, forming a space into which fluid will collect, and gradually press and condense the cellular tissue around. Ultimately it becomes organized into a sac, in a manner resembling the formation of a bursæ under friction. Sometimes the cyst is composed of connective tissue, as in certain cutaneous cysts. These may also be in deep-seated organs as well as in the skin. They may be congenital. The type of this form is found in the ovaries in connection with tumors containing what is natural upon skin, as hairs and hair follicles.

Treatment.—I shall speak only of those upon the surface of the

body. Occasionally by puncturing the sac and allowing the contents to escape, a cure may be effected. Thereupon the walls of the cyst may unite by adhesion, or gradually shrivel up, and be removed by the absorbents. Sometimes when a duct is occluded it may by a small probe be reopened. But excision is the most certain method of treatment, and when practicable, should be adopted. Unless the cyst has become adherent to the surrounding tissue, which may have resulted from inflammation, there will be no difficulty experienced in performing the operation. It is not necessary to excise the cyst entire. On the contrary, by opening it and allowing the contents to escape, the cyst may be easily detached from its bed and extracted. It is well to remove the whole of the cyst, lest from even a small portion remaining, the growth should recover. A degree of inflammatory action after removal is desirable to complete the destruction of the cyst, so union should not be sought for in treating the wound made by the surgeon. To secure destructon of every part of a cyst it is sometimes necessary to apply the nitrate of silver after removal.

Glandular Tumor.—By this, reference may be made to morbid growths arising from glandular structures, or to those which bear some resemblance to glandular tissue. Not unfrequently, tumors are formed by enlarged glands, as a lymphatic gland; or the lobe of a larger gland may be enlarged. Sometimes a tumor, with a structure like that of a gland, will be found in close proximity to a gland.

Treatment.—Before it has attained to a very large size, it may sometimes be dispersed by the exhibition of iodine in some form, and the application of the tincture of iodine. I have also seen the tincture of iron, alone, and in conjunction with extract of belladonna, have a beneficial effect in dispelling the tumor.

Extirpation should be unhesitatingly resorted to, unless the tumor be very deeply-seated and large. Considerable care will be necessary to separate it from the tissue in which it is imbedded.

Vascular Tumor.—This is a very interesting class of tumors, which are of common occurrence. The morbid growth is made up of normal vascular tissue, in which the blood circulates freely. The blood in the tumor will not always be found in the same quantity, and consequently its size will not always be the same, but will from time to time vary. The bloodvessels are enlarged in

size; their calibre is increased; their number greater. They may resemble the arterial, or the venous, or the capillary vessels; and the blood occupying the tumor may be arterial or venous. When

the structure is filled with venous blood, the tumor presents a bluish appearance; when it is arterial blood, the tumor is reddish, and constitutes aneurism by anastomosis. These growths are most frequently seen in the skin or subcutaneous tissue; they may, however, exist in deep-seated structures. They may come after birth, but are more generally congenital. Of a large number that have come under my care and notice, I never saw one not congenital. They commonly go by the term nævus, or mother's mark, from the belief that certain impressions on the mother during pregnancy were fixed upon some part of the child in the womb. At birth it may be very small; but in a few weeks, or months, perhaps a longer time,—in consequence, seemingly, of the larger quantity of arterial blood circulating therein,—its growth will be found far in excess of other structures of the body. The face and head are the situations more commonly the seat of vascular tumors. When venous, and presenting a dark-blue appearance, it is sometimes looked upon by the non-professional as a cancerous formation.

Diagnosis.—The educated surgeon, of any experience, is not likely to be at a loss to recognize a vascular tumor. The appearance and the history of the case are generally fully sufficient to indicate its character.

Treatment.—Being unsightly, the surgeon is generally sought to treat it; but sometimes the superstitious will hesitate to have anything done with a "Providential thing." If the tumor does

not grow, it may safely be allowed to remain. A cure may be attempted by pressure; by injecting perchlorate of iron, to produce consolidation of the contents; by creating inflammation, which may be produced by a variety of ways; by the use of the potential or the actual cautery; by ligature; by excision. If the tumor is small in circumference, and overlying a hard structure, as a bone, a cure is quite possible by protracted pressure. Injecting the iron is highly recommended by some, but sometimes its use is followed by a great deal of local inflammation. However, inflammatory action within bounds cannot but further the process of cure. There are a variety of ways in which inflammation may be induced. Vaccination is an old method, but the better one is the introduction of a seton through the tumor. Cauterization, in the first place, destroys a portion of the nævus, and then, by establishing inflammation in the other portion, adhesion and obstruction of the feeding-vessels result, and thereby a cure. Nitric acid, and similar caustics, may be used to advantage; but unseemly scars are likely to remain, and this, especially when upon the face, is very objectionable. Whatever will destroy and at the same time dry up the substance, is the most preferable. I have, in a good number of cases, employed satisfactorily the actual cautery, in the following manner, with a spirit-lamp, and a supply of needles fixed in wood or cane. The patient, if necessary, is put under the influence of chloroform. The needles are heated to white heat, and then with quickness introduced at the base of the tumor, and made to transfix it. This is continued until the whole mass is a black, lifeless eschar. I have then, in most cases, applied a tolerably thick coating of collodion. No pain followed, no inflammation to signify. The ligature may be employed to strangulate the growth. A needle with the thread may be made to transfix the tumor at its base, in one or two places, and then the ends so tied together as to completely surround and strangle the growth. The needles may be allowed to remain, and the ligature wound around several times tightly.

The tumor can be often excised; and this is the most expeditious way of removing, though not so commonly chosen by the patient. The knife must be passed quite outside the morbid structure, else there may be unpleasant bleeding. After cutting,

should any portion remain, it can be destroyed by the caustic stick.

Sarcomatous Tumor; Flesh-like.—This is not so well-defined as some other class of tumors. It bears a close resemblance to others, especially the fibrous. It is quite innocent in its character; generally round in shape, with an uneven lobulated surface; size varies from a hazel-nut to a fœtal head; commonly single in number, and when removed completely, it does not recur. No particular part of the body is liable to become the seat of growth.

CHAPTER XLVII.

Cancerous Tumors: Remarks—In two forms—Two stages—Microscopical appearance. Scirrhous: Varieties—Colloid—Encephaloid—Epithelial—Course—Symptoms—Terminations—Effects upon constitution. Treatment: Local and General—Extirpation—Caustic—Congelation—Pressure.

Cancerous Formations.—Thus far, in the consideration of tumors, attention has been solely directed to those which are benign, or which manifest but a tardy disposition to malignancy. The point of deviation between growths which are innocent and those which are malignant has already been indicated; but it is necessary to acquire a more distinct idea of what constitutes malignant growths—in what respect their elements differ from those to be seen in innocent but abnormal formations.

Pathology.—The most striking characteristic is their inclination and power to grow at a very rapid rate—much faster than any natural tissue can grow. And the new growth, apart from its elementary composition, is different from any natural tissue of the body, although it may bear some resemblance.

It would seem that from some cause, local or general, more pabulum than could be appropriated had existed in the part at first, and that, in consequence, the original cells of the part had given birth to a more numerous offspring of nuclei. The cells, left uncontrolled by the circumstances of the tissue, continue to grow and to be developed, the result of which is a *lusus naturæ*, per-

haps, and unlike any of the analogous formations. This new and unnatural formation, continuing to grow, at last attains to a condition of influence and power, so that it possesses distinct properties. It now begins to assert its right to rank among the structures of the body, and hereafter to be supported by the common life-blood. This view is supported by the revelations of the microscope. In no growth, natural or morbid, can be seen cells possessed of so high a vitality as in the cancerous growth. And those tumors which grow the fastest, as the encephaloid, are seen to possess far more active cells; while on the contrary, the scirrhous, which grows less rapidly, has entering into its structure far more of the fibrous element. Herein may be said to reside the peculiarity of cancer.

It is a structure, however formed, composed of morbid cells which are endowed with unwonted vitality. This is exhibited by the rapidity of its growth, and the continual begetting of numerous offspring. The greater the number of cells, the greater, the more fatal, the malignancy. And tracing the history of the tumor still farther, it is found not to rest satisfied with a position coequal with the normal structures, but aims at universal power. It commences to invade the neighboring structure in its "struggle for life," and to absorb the tissue, and to convert all into a structure like unto itself. The blood is placed under contribution, and gives, at the expense of normal tissues, to the imperative demands of the cancer.

Cancer is unlike the tumors heretofore considered. They were

but local affections, due in the main to local causes; but cancer is a constitutional affection. The tumor is only a local manifestation of the general morbid diathesis. And what is this diathesis? what is its origin? whence the fearful malignancy which displays itself in draining the life-blood, and exhausting the powers of life, never resting satisfied until the life of the individual is at an end? Unfortunately pathology has not yet uncovered the cause of the malady. The disease is as mysterious as it is fearful; in its origin it is as uncertain as its end is certain and deadly. The disease may be said to be local in this respect: the great error seems to be located in the blood. Looked at by the naked eye nothing can be discovered, yet this fluid possesses something unnatural or is wanting in something essential to true vitality.

The disease is hereditary and may be transmitted down through many generations, yet it would seem often to arise spontaneously, and to possess quite as much malignancy. There is very slender proof that the disease may be communicated from one individual to another. It is neither possible nor desirable to introduce the different views of eminent writers on pathology respecting cancer, but I will give those advanced by Mr. Simon, in his "General Pathology." He says: "Thrust aside all the accidents and trivialities of the subject, strip the question naked, and what does a cancer mean? Substantially it is a new excretory organ. Under the pressure of some mysterious constitutional necessity, a growth arises which (in its typical form) tends essentially to acts of eliminative secretion, just as distinctly as the healthy liver or the healthy kidney. You must not stop short at the *tumor;* you must scan the whole drama of the disease, in which the tumor forms but a *proœmium.* Look again at such a case as I gave you for illustration—a case of encephaloid manifested in the globe of the eye, that vast fungating ulcer which ensues on the protrusion of the tumor, and which continues hourly to purge forth its profuse discharge—that is the real intention and purpose of the tumor, as palpably as urine expresses the intention of the kidney, or bile the intention of the liver. The cells of the tumor have grown like healthy gland-cells—like the nucleated cells of a mucous membrane, only to discharge themselves with their contents. There is nothing, I repeat, like hypertrophy in the disease; it consists essentially in the establishment of a new vent—a new

organ of elimination, and that organ develops itself as an apparatus for the formation of deciduous cells."

Stages.—Cancerous growths may be said to have two stages; the first is that of development, the second of maturity. During the first there is generally a good degree of firmness, and during the second there is a tendency to softening.

The morbid material is not always in the form of a tumor, it may instead be deposited in the tissue of an organ. In the latter case the course is less rapidly run, and it is not possessed of so much malignancy. The cancerous mass, speaking generally, is composed of a fibrous framework, more or less extensive, and of a fluid alive with cells. This fluid is called the *cancer juice*. Of course, the more there is of the fibrous element the more firm will be the mass, and on the contrary, the less there be, the less the consistence.

Microscopical Appearance.—Under the microscope the following are found to be the characteristics of the cancer juice. There are "essentially forms and steps of microscopical cell-growth, round or oval cells like pus-globules, with dotty contents, and with a nucleus more or less distinct, or cells like those of glands or ganglia, more opaque with granular material, round or angular, or developed into processes, and having one nucleus or several, or gigantic mother cells containing within them simple cells of a new formation, nuclei and granular matter, or cells in various degrees of blackness with pigment, perhaps to an amount which shall render the whole mass *melanotic*, or spindle-shaped bodies with oval nuclei, indicating the commencement of new fibre, or free nuclei, some round and oval, with simple nucleoli, having the size of normal gland cytoblasts, others twice or thrice as large, elliptical, with double nucleoli, or elementary granules of all sizes, or glomeruli consisting of them. And for the intercellular material, it has no high development in such cases; sometimes it will be so amorphous and incoherent that the microscope cannot identify it; sometimes it will be more fixed, but scarcely more shaped, having the faintest appearance of fibre, and carrying a few elongated nuclei in its substance." (Simon.)

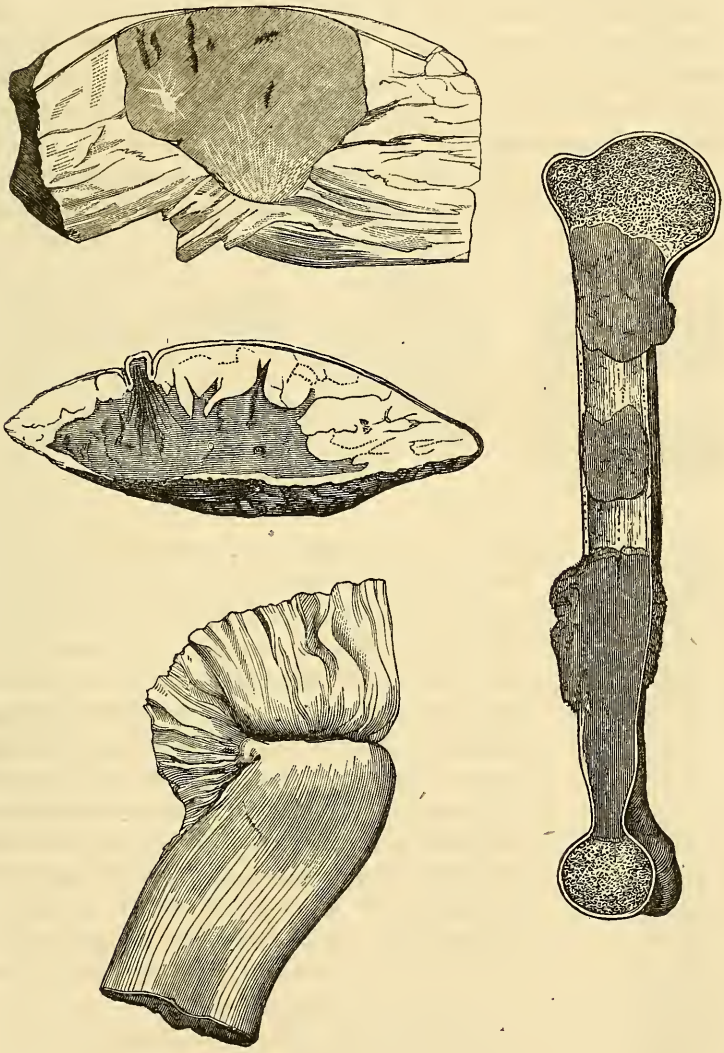
As before stated, the heterology of cancer does not consist in a dissimilarity in the ultimate constituents of the mass from all other elements of the body, nor yet in any chemical deviation. Rather,

it is in the crowded state of the microscopic cell, the variety and number of which are at once seen, and which manifest such a lively activity, leading to such unnatural growth of the mass.

Varieties.—The cancerous disease presents itself in different forms, as to consistence and to external appearances. The whole can be well enough presented by speaking of the scirrhous, the colloid, and the encephaloid, also the epithelial. Again, cancer may be a *primary* growth or a *secondary formation.*

Scirrhus Cancer is characterized by great firmness of structure, the fibrous element being largely in excess of the cancerous juice, therefore the growth is less rapid, also there is less malignancy. The stroma frequently is composed of the original tissue, that is to say, the morbid material had been deposited in the interstices of the tissue, although after a time, from the presence of the deposit, the network had become quite changed in its nature and appearance. The tissue in which the disease exists, as well as the structures immediately around, will often give character to the mass. The greater the degree of resistance the greater the effect produced; consequently the outside view of the mass and the appearance on section, will in one case present one form, and

in another case another form. Hence a variety of names have been given to this species of cancer, based entirely upon the arrangement of the fibrous stroma, which arrangement is due to the

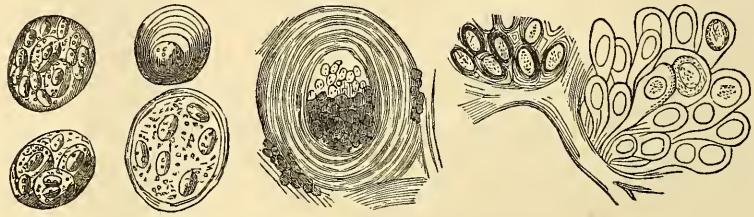


character of the pressure to which it had been subjected. Thus the tumor may be *lobulated*, being intersected by bands, or it may

be of a *mammary* form, so called because of resemblance to the mammary gland; or the *pancreatic*, like the pancreas; or it may be *reticular* in form; occasionally it has an *alveolar* arrangement, also *nœpiform*, turnip-like. Then there is the *lardaceous* variety, which "closely resembles a section of the rind of fresh pork." (Gross.)

Habitat.—The most frequent habitat of scirrhus are the female breast and the uterus, the lips, the stomach at the pylorus, the rectum, the penis, and sometimes the bones. I had a case but recently where the whole of the intestines were involved.

Colloid Cancer.—This is a variety of less frequent occurrence than either of the others. It is characterized by a gelatinous,



jelly-like appearance, and is made up of a delicate fibrous framework, which contains the gum-like juice. The greater the quantity of fibrous element, the more firm the cancer will be. The substance within is quite transparent, colorless, and is likened to the crystalline lens. (Simon.) It may be seen sometimes standing out on the surface like the translucent gum of a balsam tree. The deposit more commonly takes an alveolar arrangement; and hence it is often called alveolar cancer. It may exist in the form of a distinct tumor; or it may be infiltrated. The colloid cancer is met with in the stomach, rectum, upon the omentum, in the bones, ovaries, and kidneys.

Encephaloid or Medullary Cancer.—In this form is seen the widest departure from normal structure. The mother cells are the largest, and the most crowded; the nuclei and granules the most numerous and varied. It is of all the most malignant

in its behavior. It is called encephaloid in consequence of its resemblance to the brain; and this likeness consists not only in the appearance, but in the consistence, and the chemical composition; but not necessarily in all respects at the same time. The encephaloid differs from the scirrhous only in that the true cancer elements far exceed the fibrous. Hence the great rapidity of growth which characterizes this form of cancer, and the quickness with which the powers of life are exhausted. The encephaloid has always a freer supply of bloodvessels; a condition necessary for the great activity of the cancer cell. Sometimes the number of vessels is so great that thereby a decided color is imparted to the growing mass. This variety is commonly called *fungus hæmatodes*. The coats of the vessels are attenuated, and easily break down. While the mass grows luxuriantly, bleeding, upon the slightest cause, will take place. Again, *melanotic* matter may be intimately deposited through the mass, producing the specific kind known as *melanosis*, or melanotic cancer. But while this pigmentary substance is more frequently deposited in the encephaloid cancer, it is also met with in other forms of cancer, as well as in the benign tumors, and even the natural tissues; while in the negro, it is a natural constituent of the skin. The term *soft* cancer is sometimes applied. This is when the brain-like mass is very soft; for the substance will be found to vary from the consistence of cream to that of fibro-cartilage.

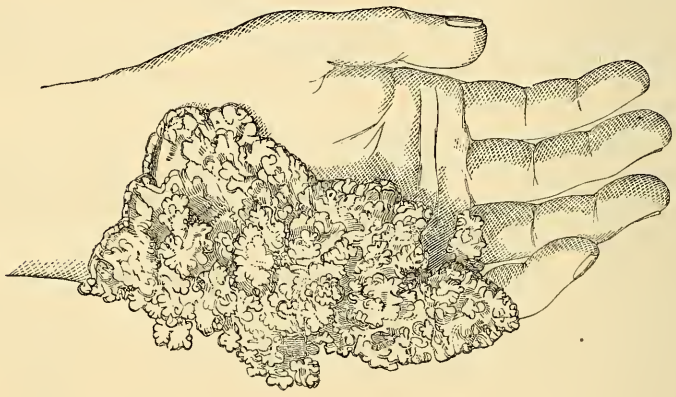
The cancer may be in the form of a tumor, or it may be a mass divided into lobules, with their delicate partitions; occasionally bearing resemblance to the placenta, or a clot of blood, or the matter may occupy the natural tissue, having been infiltrated; yet the framework will have undergone decided changes. Here and there a lobule may present a pointing appearance, especially in the former kind, like as in an abscess. This will eventually burst, if it be not broken or opened by the surgeon. After this the wildest growth will take place in the mass, attended with a discharge of a bloody nature.

Habitat.—The parts of the body in which the encephaloid most frequently grows, are the head, face, and from the cavities thereof, from the breast, the testes, likewise the limbs. It may arise, however, in almost any part of the body.

At first the growth may be deep-seated, and its nature undis-

covered, but eventually approaching to, and then standing out from the surface, a rapidly growing, livid, soft formation, its character will no longer remain unknown.

Epithelial Cancer.—This affection is in several respects different from either of the afore-discussed. Its name indicates that the habitat of the disease is in membranes with an epithelial covering. It is upon the skin and mucous membrane, membranes exposed to air, that it is almost altogether met with. Not only is it singular in this respect, but also in being far less malignant than any other form. Indeed, it is questioned by some whether this should be classed among cancers, inasmuch as it seems to arise without any perceptible constitutional cancerous diathesis. It is proposed by some to call it *epithelioma* or *cancroid.* Again, as it closely resembles scirrhus, it might, at least it has been included among the scirrhous variety.



The general appearance of this tumor is that of "an exuberant warty growth," presenting a pale white, reddish color. Sometimes it has a smooth surface, but more frequently it presents a peculiar tuberculated form, with perhaps ulcerations, and dark red crusts on their exterior.

As before stated, it seems to have a preference for the skin and mucous membranes, especially at the mucous orifices. The most common seat is the face, particularly the lower lip, but it also comes at times on the tongue and the cheeks; occasionally it forms as well in the larynx, pharynx, and trachea. Another common

locality is the scrotum, in the form of chimney-sweep's cancer. It may appear anywhere around the organs of generation. In the female it may arise in the walls of the vagina, or about the neck of the uterus in the form of a cauliflower excrescence.

The disease is said to occur more frequently in the male than in the female.

It may be safely said with respect to this form of the disease, that it would never arise unless some local cause was brought into operation. For instance, smoking, especially a short and old pipe, is a common cause of the disease upon the lower lip. Also, on the scrotum, it is frequently due to continued irritation of soot, to which the chimney-sweep is exposed. Although there might be a cancerous diathesis, yet it is not sufficiently developed to originate a local disease, did not some local and long-continued irritation lead to it.

Course, Symptoms, and Terminations of Cancer.—There are to be considered, first, the primary, and secondly, those which are designated secondary formations.

Although all cancers, excepting the epithelial, may be said to be ever going on to a termination fatal to the life of the individual, yet a great difference will be observed as to the time requisite to complete its course. An active encephaloid may run its course in a few months, while a scirrhus of minor malignancy may occupy a long series of years; and, indeed, some other disease may intervene to close the patient's suffering.

The scirrhus is always less rapid in its growth than the encephaloid, but is generally the cause of far greater suffering. In many cases of cancer, speaking of all, the first knowledge the patient will have of the existence of the tumor, will be occasioned by shooting pains in the place of location. Then, if it be superficial, a lump of small size, hard and movable, will be felt in the structure. The pain will sometimes be very great, so great and distressing, that when the disease is deeply seated, and there is no other sufficient cause for it, it may be regarded as almost a diagnostic mark. The tumor as it grows in size, will become more painful; and instead of remaining movable, will become more fixed. It is, indeed, attaching itself to the surrounding tissue, by sending into it prolongations, and gradually converting it into a cancerous structure. At this time the glands near to the growth will very

likely receive deposits of cancerous material in their structure. The size of the tumor occasionally may suddenly increase, from inflammatory action, and again resume its previous condition; but on the whole the growth will steadily advance. Often one portion will grow more rapidly than the other. Although at first quite subcutaneous, and unattached to the skin, it ultimately involves that in the disease. The tumor, now upon the surface, and standing out, will, in many cases, lead to ulcerative destruction of the surface, perhaps to sloughing, forming an ulcer of a most loathsome nature. From this will continue to pour a bloody pus, mixed with detritus. The mass continuing to extend to parts around, will literally eat them up and pour them out in the foul ulcer. It is when the cancer is thus open, that the term "cancer" may be more appropriately used. Death may soon come from this incessant drain upon the system; and the pain will assist to prostrate the system. But death may come in a more speedy manner by the cancer eating into a large artery, and producing hemorrhage. A generally recognized symptom of the cancerous diathesis is a sallowness of the skin. In cases of tumor of doubtful character, this appearance will assist in the diagnosis.

The course and termination of the encephaloid is marked by more fearful symptoms, and is more quickly fatal. It will often spring up like a fungus, spontaneously perhaps from a cavity about the face, or from the head; sometimes it will arise from an injury, or a wound, instead of healing by granulation, sends forth malignant sprouts, which will grow apace, as if the disease had waited such an outlet by which to manifest itself. Very soon, in whatever way the disease arise, the structures around become a part of the mass. The discharge will be mostly the same as that seen from the open scirrhus. The tumor is more soft than the scirrhus, and the pain much less. Exhaustion and death cannot be long delayed.

The epithelial cancer is slow in its course, and doubtful in its result. For a long time it may be uncertain whether it is malignant or not. But when it does attain to true malignancy, it exhibits characteristics no less destructive and uncontrollable than that which, at the first, displayed its true character. Cases have come under the notice of almost every surgeon, where the disease, coming perhaps upon the lip or the cheek, and for a long time

seeming to be only a warty growth, has slowly but surely extended inward, and to parts around. At last it ulcerates, and is covered by a cream-like fluid resembling pus. It continues to extend, eating its way through all structures, cartilage, bone,—everything. It now and then happens that extensive inflammation is induced in the epithelial cancer at an early date, before it has had a converting influence upon the adjacent tissue. The inflammation destroys the morbid mass, and the disease is averted. The ulcer remaining, heals up in a healthy manner. This unfortunately is of rare occurrence.

Effects upon the Constitution.—Notwithstanding the disease is a constitutional one, and that the seeds of the malady will have been long sown, yet the individual will have experienced no illness, not even the slightest symptom had whispered to him the coming horror of a cancer. Every organ and its function will have been perfectly normal, until the local manifestation presented itself. But very soon thereafter the hitherto latent disease displays itself in constitutional symptoms, which seem to arise entirely from the local deposit. We have learned that the cancer mass may be primary or secondary; and that first there is generally but one, while in the secondary there may be several. In order to have the secondary deposits made, there is generally an actual passage of the cancer substance from one place to another. During the progress of the disease thus indicated, whether the original virus in the blood is being intensified by the local disease as well as by development, may be questioned, but this much is true,—at once after the local disease is established the powers of life begin to suffer—to fail. The great pain, and subsequently the discharge, contribute largely to the general cachexia, also, no doubt, consciousness on the part of the patient that his malady is incurable. The constitutional cachexia is always better marked in the encephaloid form.

Treatment of Cancer—Local and General.—The sad fact that cancer is incurable stares us in the face, always excepting the epithelial form; and it is an affection over which nature seemingly has no control. But very much can be done by the surgeon to palliate the symptoms, and often to prolong life.

It might seem that, as the disease may, and often does remain latent for a long time without manifesting itself locally, the removal of the local deposit when possible would arrest the malady,

at least for a time. But unfortunately experience has proved that such is not to be expected. There is hardly one well-authenticated case recorded, in which removal of the cancerous mass had the effect of staying the disease. Having once exhibited itself, it is no longer willing to remain in obscurity. Finding itself possessed of power to grow, and to outgrow normal tissue, it will soon seek and find another, or several other localities, wherein to assert its power. Indeed it would seem, at least in many cases, that the removal of the primary tumor aroused the disease to a more energetic action. This fact has led some to say, that if the primary tumor remain untouched, the disease will display less activity, and the patient's life be more prolonged than when removal is made, to be followed by the more malignant secondary deposits.

With regard to the removal of single primary cancerous tumors, it is not well to lay down a general rule. If the tumor is exposed and painful, or a cause of great inconvenience, the surgeon may the more readily determine to advise its removal; but it will be preferable to lay the matter fully before the patient and his friends; and then, although guiding their judgment to a great extent, be guided by their wishes. The family history must be taken into consideration; if there be no evidence of family predisposition, probably the growth will not so speedily return, if removed. Of course, should any other disease exist, which might interfere with the success, removal will not be undertaken. The tumor must not be too large, and it must be circumscribed somewhat.

Having decided to remove the mass, care must be taken to secure a complete extirpation. Often there will be prolongations, roots dipping down into the tissue around; these, so far as possible, must be removed. Again, very often the glands in the vicinity are the seat of deposit, and must also be removed. Sometimes a limb will be so involved that the only effectual way of extirpating the disease is to amputate the limb above the disease.

As to constitutional treatment, it has already been stated that cancer is incurable, that at present there is no remedy known which will, by internal administration or by application, cause a dispersion of a cancerous growth, or to any extent arrest it in its disastrous course. While medicines may often be given to advantage to palliate distressing symptoms, as anodynes to relieve

pain and secure some rest, nothing can be done specifically. It is the testimony of the best and latest authority, that the principal thing to be done is to attend to the general health; that the tumor, as a general thing, does not grow so fast when the health is good; while, if it be impaired, the cancerous formations will increase more rapidly. With anodynes, then, supply good food, and see that the various organs are in a healthy state of action. To fulfil these indications it may be requisite to give tonics, or iodine, or alkalies, or iron, or chlorine, according as certain conditions of the system may demand.

Local treatment of those which cannot be extirpated will be based upon the same general rules, that is, to make the part as comfortable as may be, and to palliate. While the growth is yet a tumor, it should be supported by a bandage, or some suitable apparatus. Nothing should be applied that will irritate or excoriate. Too often such applications are used, and aggravate the symptoms. Opium in some form, perhaps with belladonna, is the most suitable application. When the tumor ulcerates and a discharge issues, still the treatment will be palliative and non-irritating. Protect the part, attend to the discharge, and if bleeding should threaten, or actually come, take the necessary steps for arresting it, if possible. An occasional poultice and an opium or lead lotion will often afford considerable comfort. "The oxide of zinc, trisnitrate of bismuth," or "similar preparations may be applied in the form of powder or ointment." (System of Surgery.)

The use of Caustic.—The use of caustic has, with some, obtained favor. In 1857, Dr. Fell, of the United States, was allowed to test the principles of this practice in the Middlesex Hospital, London. The chloride of zinc, made into a paste with flour, was employed, the skin being destroyed by ulceration, or by artificial means. But the report on this treatment, from that institution, failed to satisfy the profession that that method was entitled to any important consideration.

Treatment by Congelation has been likewise tried without being found to possess any important advantage. It is less painful than the caustic, so if one were to be tried, it might have the preference. The *application of a ligature* is of more commendable service. Should it be difficult to use the knife to extirpate, or to remove a portion of the mass, the ligature may be made to em-

brace the desired portion. But in all of these cases it will be remembered there will remain a space more or less great, to be closed up, if closed at all, by the healing process; and it can scarcely be questioned that this is more likely to be accomplished quickly after removal by the knife.

Pressure has been employed to dissipate cancerous tumors, and according to some, has led to considerable reduction in the size of the tumor. The pressure, if made, must be regularly diffused, and unattended with any irritation of the part, or inconvenience to the patient.

Treatment of Epithelial Cancer will be somewhat different from that recommended for cancers generally. This would be expected from the great difference which exists between the two. In the first place, when an epithelial cancer is beginning to form, very often, by doing away with the cause—some irritation—the growth may be arrested, and therefore be gradually absorbed. The irritation may arise from smoking, or exposure to soot, as in the chimney-sweep, or it may be due simply to continued manipulation on the part of the anxious patient, to see if it is growing. I have seen not a few cases in which suspicious growths were observable about the face, and growing apace, but which ceased to grow upon being let alone. Not only are these often made to grow by constant feeling of them, but more particularly by using all sorts of applications "to drive them away." All such should be steadily avoided.

When an epithelial cancer is undoubtedly growing, it ought at once to be removed by excision, thorough excision. The chances are it will not return, yet sometimes it does.